6. Lightweight Materials

Advanced materials are essential for boosting the fuel economy of modern automobiles while maintaining safety and performance.

Because it takes less energy to accelerate a lighter object than a heavier one, lightweight materials offer great potential for increasing vehicle efficiency. Replacing cast iron and traditional steel components with lightweight materials such as high-strength steel, magnesium (Mg) alloys, aluminum (Al) alloys, carbon fiber (CF), and polymer composites can directly reduce the weight of a vehicle's body and chassis by up to 50% and therefore reduce a vehicle's fuel consumption. A 10% reduction in vehicle weight can result in a 6%-8% fuel economy improvement.

By using lightweight structural materials, cars can carry additional advanced emission control systems, safety devices, and integrated electronic systems without increasing the overall weight of the vehicle. While any vehicle can use lightweight materials, they are especially important for hybrid electric, plug-in hybrid electric, and electric vehicles. Using lightweight materials in these vehicles can offset the weight of power systems such as batteries and electric motors, improving the efficiency and increasing their all-electric range. Alternatively, the use of lightweight materials could result in needing a smaller and lower cost battery while keeping the all-electric range of plug-in vehicles constant.

Using lightweight components and high-efficiency engines enabled by advanced materials in one quarter of the U.S. fleet could save more than 5 billion gallons of fuel annually by 2030.

The U.S. Department of Energy (DOE) Vehicle Technologies Office (VTO) collaborates with industry to improve materials that will increase vehicle efficiency while meeting consumer and industry expectations. It does this through work on both Lightweight Materials and Propulsion Materials. In the case of Lightweight Materials, VTO works to lower the cost and improve the properties of lightweight materials while maintaining safety, comfort, reliability, performance, recyclability, and cost.

Research and development is done in collaboration with industry, national laboratories, and universities. VTO contributes to the Materials Genome Initiative, a federal interagency effort to support Integrated Computational Materials Engineering. It also works through government/industry partnerships:

- The U.S. DRIVE Partnership focusing on light-duty vehicles
- The 21st Century Truck Partnership, focusing on heavy-duty vehicles
- The US Automotive Materials Partnership (USAMP).

The Lightweight Materials subprogram’s major R&D goal by 2015 is to validate the ability to reduce the weight of a passenger vehicle body and chassis system by 50% compared to a 2002 vehicle. This reduction needs to be cost-effective and the materials need to be recyclable as well.

Subprogram Feedback

DOE received feedback on the overall technical subprogram areas presented during the 2015 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE VTO subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1. Was the program area, including overall strategy, adequately covered?

Question 2. Is there an appropriate balance between near- mid- and long-term research and development?

Question 3. Were important issues and challenges identified?

Question 4. Are plans identified for addressing issues and challenges?

Question 5. Was progress clearly benchmarked against the previous year?

Question 6. Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7. Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8. What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9. Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10. Has the program area engaged appropriate partners?

Question 11. Is the program area collaborating with them effectively?

Question 12. Are there any gaps in the portfolio for this technology area?

Question 13. Are there topics that are not being adequately addressed?

Question 14. Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15. Can you recommend new ways to approach the barriers addressed by this program area?

Question 16. Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: Will Joost (U.S. Department of Energy) - lm000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:

The reviewer said that the overall strategy for materials was well identified, particularly the Materials Technology Gap Priorities slide. However, the reviewer did not see propulsion represented in this slide, only the lightweight materials. The reviewer recommended a similar prioritization be shown for the propulsion technologies, and also recommends showing a clearer breakdown of which items are higher priority.

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Reviewer 1:

The reviewer said that the presentation gave a good overview of the challenges that the materials team is facing and some of the research and development, but delegated much of the explanation of the research and development to the individual project presentations. The reviewer recommended that it would have been clearer showing how the projects are linked into stated project goals instead of a list of projects explaining what the projects are currently doing.

Question 3: Were important issues and challenges identified?

Reviewer 1:

The reviewer said that key challenges were explained and summarized well.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:

The reviewer said that the roadmap addresses many of the challenges and the plans to address them.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:

The reviewer did not see a clear comparison to the previous year. The highlights shown gave some indication, but the few shown did not mirror the breadth of projects.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:

The reviewer said that the projects are addressing broad problems and barriers.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:

The reviewer said that the program appears well focused and managed tactically, but the broader strategic goals and timeframe to accomplish the goals were not shared.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:

The reviewer said that the overall plan, particularly for lightweight materials, seems to be an all of the above strategy. The reviewer expects that eventually there will be a drive to down-select some of the alloy categories, but the reviewer agrees that would be premature at this stage. The reviewer said that one strength of this program is that the projects under this program area appear to be high risk/high reward, and that one weakness is while both the lightweighting and propulsion sub-programs contain a computational or integrated computational modeling (ICME) approach, the projects seem to be separate, rather than integrated or weaved into existing programs.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:

The reviewer said that there is insufficient information to evaluate if the approaches are novel or innovative.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:

The reviewer said that the program seems well-integrated into federally funded research centers, industrial and academic partners.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:

The reviewer said that the program has done a good job of facilitating interaction between these groups.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:

The reviewer sees a few gaps. The reviewer asked what materials beyond Mg and CF composite will be needed to reduce weight beyond 37%, and how are predictive models shared and/or translated from academic to industrial use.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:

The reviewer said that it is difficult to assess if topics are not being adequately addressed. The program area is very broad, and there will always be tradeoffs on what can be accomplished with limited funding.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:

The reviewer pointed out that there are still a number of challenges in Al and steel that are unaddressed and sparsely represented in the projects, as well as materials for glazings and other car components that could be used to lightweight the vehicle.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:

The reviewer said that overall, the program area seems well aligned to deal with many of the barriers.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer said that it is difficult to evaluate the effectiveness of the program area with the information provided.

Project Feedback

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses (*on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Advanced Oxidation and Stabilization of PAN-Based Carbon Precursor Fibers	Paulauskas, Felix (ORNL)	6-9	3.33	3.33	2.83	2.83	3.21
Scale-Up of Magnesium Production by Fully Stabilized Zirconia Electrolysis	Powell, Adam (INFINIUM, Inc.)	6-11	3.50	3.38	3.00	3.25	3.34
Mechanistic-Based Ductility Prediction for Complex Magnesium Castings	Sun, Xin (PNNL)	6-15	3.63	3.50	3.63	2.88	3.47
Multi-Material Lightweight Vehicles	Skszek, Tim (Vehma)	6-18	4.00	3.67	3.83	3.67	3.77
SPR Process Simulation, Analyses, and Development for Magnesium Joints	Stephens, Elizabeth (PNNL)	6-21	3.00	3.00	3.17	3.00	3.02
Understanding Protective Film Formation by Magnesium Alloys in Automotive Applications	Brady, Mike (ORNL)	6-23	3.00	2.83	2.67	2.83	2.85
Magnesium-Intensive Front End Sub-Structure Development	Quinn, Jim (United States Automotive Materials Partnership)	6-26	4.00	4.00	3.83	3.67	3.94

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Aluminum Formability Extension through Superior Blank Processing	Sun, Xin (PNNL)	6-29	3.50	3.50	3.50	2.50	3.38
Enhanced Room-Temperature Formability in High-Strength Aluminum Alloys through Pulse-Pressure Forming	Davies, Rich (PNNL)	6-32	3.33	3.17	3.33	3.00	3.21
Integrated Computational Materials Engineering Approach to Development of Lightweight 3GAHSS Vehicle Assembly	Hector, Lou (United States Automotive Materials Partnership)	6-34	3.75	3.25	3.75	3.13	3.42
GATE Center of Excellence at UAB for Lightweight Materials and Manufacturing for Automotive, Truck and Mass Transit	Vaidya, Uday (Univ Alabama Birmingham)	6-37	3.00	3.25	3.50	2.88	3.17
Validation of Material Models for Automotive Carbon Fiber Composite Structures	Berger, Libby (GM)	6-41	3.25	2.88	3.63	2.88	3.06
Collision Welding of Dissimilar Materials by Vaporizing Foil Actuator	Daehn, Glenn (Ohio State University)	6-44	3.50	3.67	3.00	3.17	3.48
Active, Tailorable Adhesives for Dissimilar Material Bonding, Repair and Assembly	Haq, Mahmood (Michigan State University)	6-46	3.00	3.17	2.50	3.00	3.02

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
High-Strength Electroformed Nanostructured Aluminum for Lightweight Automotive Applications	Ruan, Shiyun (Xtalic Corporation)	6-49	2.88	3.00	2.75	3.00	2.94
Technical Cost Modeling for Vehicle Lightweighting	Mascarin, Tony (IBIS Associates)	6-53	3.13	3.00	3.00	2.63	2.98
Phase Transformation Kinetics and Alloy Microsegregation in High-Pressure Die Cast Magnesium Alloys	Allison, John (U of Michigan)	6-56	3.50	3.38	3.25	3.38	3.39
In-Situ Investigation of Microstructural Evolution During Solidification and Heat Treatment in a Die-Cast Magnesium Alloy	Rohatgi, Aashish (PNNL)	6-59	3.13	2.75	3.00	3.13	2.92
High-Throughput Study of Diffusion and Phase Transformation Kinetics of Magnesium-Based Systems For Automotive Cast Magnesium Alloys	Lou, Alan (Ohio State University)	6-62	3.63	3.50	3.25	3.50	3.50
Microstructure and the Corrosion/Protection of Cast Magnesium Alloys	Sieradzki, Karl (Arizona State University)	6-65	3.33	3.50	2.67	2.83	3.27

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
A System Multiscale Modeling and Experimental Approach to Protect Grain Boundaries in Magnesium Alloys from Corrosion	Horstemeyer, Mark (Mississippi State University)	6-68	3.50	3.50	1.67	3.17	3.23
Corrosivity and Passivity of Metastable Magnesium Alloys	Song, Guang-Ling (ORNL)	6-70	3.33	3.17	2.67	3.00	3.13
Laser-Assisted Joining Process of Aluminum and Carbon Fiber Components	Sabau, Adrian (ORNL)	6-73	3.13	3.13	3.00	2.75	3.06
Brazing Dissimilar Metals with a Novel Composite Foil	Weihs, Tim (Johns Hopkins University)	6-76	3.17	3.17	2.83	3.00	3.10
High Strength, Dissimilar Alloy Aluminum Tailor-Welded Blanks	Hovanski, Yuri (PNNL)	6-78	3.83	3.83	3.83	3.83	3.83
Upset Protrusion Joining Techniques For Joining Dissimilar Metals	Logan, Steve (Fiat Chrysler Automobiles US LLC)	6-80	3.17	3.67	3.17	3.50	3.46
Overall Average			**3.37**	**3.32**	**3.13**	**3.09**	**3.28**

Advanced Oxidation and Stabilization of PAN-Based Carbon Precursor Fibers: Felix Paulauskas (Oak Ridge National Laboratory) - lm006

Presenter

Felix Paulauskas, Oak Ridge National Laboratory.

Reviewer Sample Size

A total of three reviewers evaluated this project.

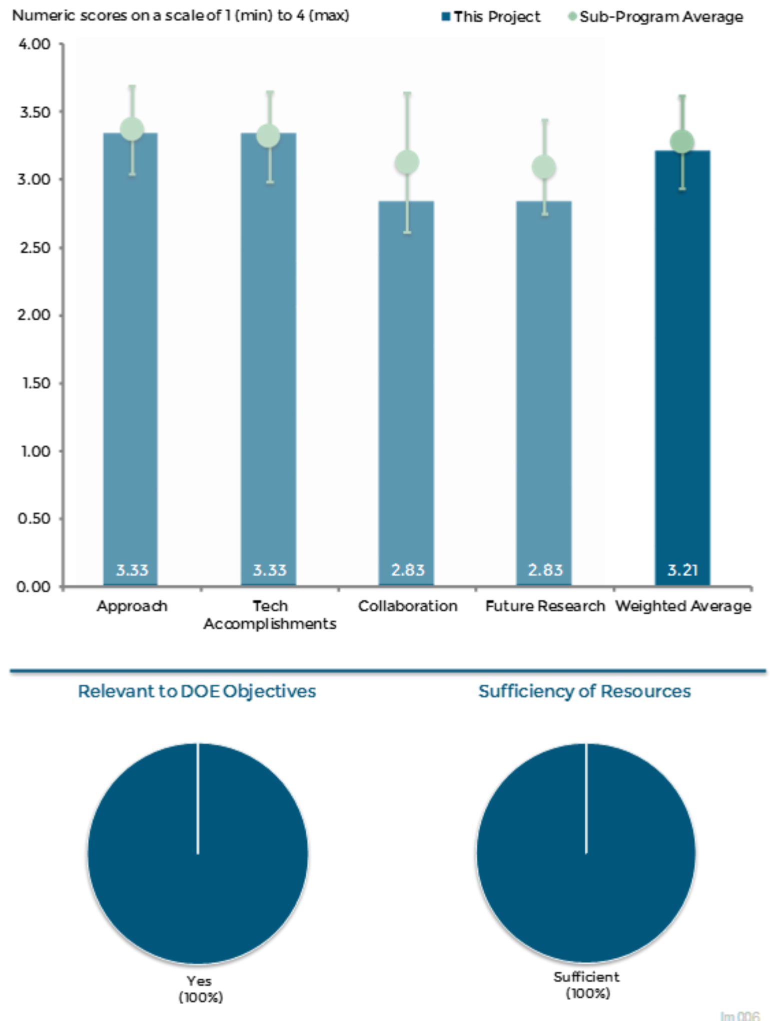

Figure 6-1 Advanced Oxidation and Stabilization of PAN-Based Carbon Precursor Fibers: Felix Paulauskas (Oak Ridge National Laboratory) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the targeted approach on a specific portion of the process is good. However, the reviewer also said the carbon fiber (CF) program seems to lack an overall approach to achieve commercial application (cost and cycle time) and environmental barriers. The reviewer commented that where we are and where we are going seem to be unknown entities.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer found that progress is good but noted that actual results are limited by export law and should be provided to reviewers to conduct an accurate assessment.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that research appears to be an exclusive activity. The reviewer remarked that the pilot line is open but the technology appears closed.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the plan is to continue, but proposed future research is lacking clear approach to what, when and benefits. The reviewer pointed out that when queried about achieving cost goals, the researcher said never. The reviewer asserted that the researcher must have realistic goals and objectives. The reviewer stated that a positive response to accepting the Funding Opportunity Announcement (FOA) goals and being knowingly aware that the goals are not achievable needs be addressed by DOE. The reviewer added that if the goals are not feasible, the project should not be awarded.

The reviewer strongly recommended that the DOE fund and conduct a life-cycle analysis (LCA) to assess current energy content associated with production, manufacturing and end of life. The reviewer said that DOE will be surprised. Much of the monetary cost of CF is related to energy. Carbon dioxide (CO_2) can be offset by using wind-based energy. The reviewer recommended that end of life (recycling) to redeploy the energy investment must be addressed.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that cost is the major enabler to commercial application of CF, the others, which include computer-aided engineering (CAE) and recycling, are not included in the scope of this proposal but significantly influence the probability of commercial application.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer pointed out that the researcher is near end of career, and asked if there is a succession plan in place.

Scale-Up of Magnesium Production by Fully Stabilized Zirconia Electrolysis: Adam Powell (INFINIUM, Inc.) - lm035

Presenter

Steve Derezinski, INFINIUM, Inc.

Reviewer Sample Size

A total of four reviewers evaluated this project.

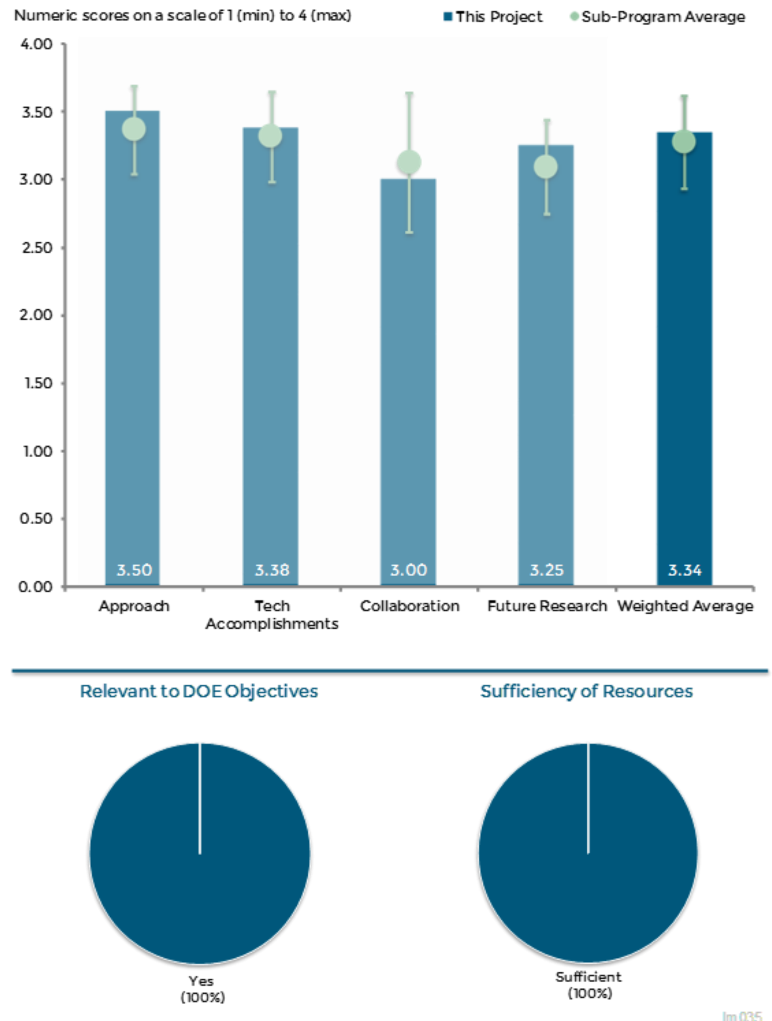

Figure 6-2 Scale-Up of Magnesium Production by Fully Stabilized Zirconia Electrolysis: Adam Powell (INFINIUM, Inc.) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that this is a very complex project with a number of key tasks and moving parts and the team is working on a new strategy that seems even more promising than the original plan. The reviewer noted that recent work has already generated positive and commercially promising results. Overall, it appeared to this reviewer that the approach is working well and the team seems to be fully capable of addressing the sort of issues that have come and are likely to in the future in a project of this nature. The reviewer concluded well done group.

Reviewer 2:

The reviewer said that roadblocks are well defined, and that scale-up issues loom. Regarding magnesium-neodymium (Mg-Nd) alloys (e.g., ZEK100), the reviewer asked how will costs associated with the rare earth (RE) elements be contained. It seemed to this reviewer that much of the customer base wants to move away from Mg-RE alloys because of cost. The reviewer asked why not for Mg-Yttrium (Y), and if there are recycling issues. The reviewer asked if there is any compelling technical reason for Nd. The reviewer said that despite these reservations, the reviewer gave this a 4.0 for the approach that is being developed, and pointed out that this is really challenging work.

Reviewer 3:

The reviewer said that INFINIUM continues to push the envelope in refining Mg using a very novel process. This is essential for starting with a high-purity Mg alloy to which we can alloy in and deliver a higher ductility Mg alloy for automotive applications.

Reviewer 4:

The reviewer noted that the work plan has been altered significantly. The project does not propose to produce primary Mg anymore. The reviewer commented that while it makes sense to produce the expensive master alloys from the market point of view, the change indicates the process may not be not viable for a large-scale Mg production.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer observed progress on all fronts, keep up the great work.

Reviewer 2:

The reviewer said that the technical accomplishments appear to be on-track and of a high caliber.

Reviewer 3:

The reviewer detailed that the project has demonstrated an ability to make very small quantities of material, and has plans to scale up to make greater than 500 lbs. The reviewer asked if the Mg material produced in this project be stampable at room temperature, or if other elevated temperature applications of the as-produced Mg alloys are planned. The reviewer pointed out that the principal investigators (PIs) have a clear understanding of energy balances, system and production costs. The reviewer would like to know what approach to optimizing process parameters will be taken.

The reviewer asked what type of automotive parts are intended to benefit from this technology. If die castings, then it is likely that the impact of this project will be less than what it could be were the focus on closure components or even other structural components.

Reviewer 4:

The reviewer said that the team had shown that it is possible to produce a Mg master alloy containing Nd. However, it will be useful to investigate further whether other RE systems can be produced.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that the reach to industry partners is noted and is excellent on all fronts; Spartan, MagPro, and Vehma are all great contacts. The reviewer encouraged the project to press on with the progress and good work.

Reviewer 2:

The reviewer remarked that it would appear that the collaboration among the team members is working well, although the level of detail that was presented as to tasking and budget split-up was rather thin.

Reviewer 3:

The reviewer observed good collaborations with Kingston Process Metallurgy, Boston University, Exothermics, Spartan Light Metals, Vehma, and MagPro. The reviewer asked how the work is being integrated together to address the production and product issues.

Reviewer 4:

The reviewer said that many suppliers are involved. However, the ability to scale-up is not yet proven.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the future directions were presented in reasonable detail and would indicate that a well-developed plan is in place, and the reviewer anticipated good results in future reviews.

Reviewer 2:

The reviewer commented outstanding, very interested in seeing the next steps to scale and make in excess of 650 lbs. The reviewer really liked a previous initiative to partner with companies to scale the process and find a low-cost power source, such as hydro-power. The reviewer asked if the project team has thought about incorporating thermal electrics to capture spent energy and re-use in other processes.

Reviewer 3:

The reviewer noted that future direction was well presented. However, it was not quite clear to this reviewer how the project will produce large enough quantities of material to address needs in the automotive industry, for example. The reviewer asked if the main applications are focused more on engine components/powertrain.

Reviewer 4:

The reviewer pointed out that only a master alloy containing Nd is being investigated. The reviewer remarked that to make this process more viable, other alloy systems need to be investigated, and the possibility of using spent magnets to recover RE elements should be investigated.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer pointed out that Mg is certainly a significant part of the picture for reducing vehicle weight (and consequently reduce fuel consumption) and so this project is definitely aligned with DOE objectives.

Reviewer 2:

The reviewer said that even though it is very long shot, production of Mg-based alloys will enhance the capability of light weighting for auto makers.

Reviewer 3:

The reviewer said that Mg development is always high on the list of automotive lightweighting options and is a major element of VTO’s objective, and that the project is well aligned and delivering as promised.

Reviewer 4:

The reviewer said that while Mg continues to face significant room temperature ductility challenges, the present project is aimed at addressing a new approach to making Mg alloys. However, it is unclear if the new Mg alloys that result from this project will be useful for closure components (hoods, decklids, doors, etc.). The reviewer noted that in the end, Mg has only two active basal slip systems and one non-basal system at room temperature. The reviewer asked how this project will overcome fundamental limitations of this hexagonal close packed material.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that no difficulties with the budget were described and so it would appear that the resources available are adequate.

Reviewer 2:

The reviewer said that the current project is appropriately funded, and the reviewer hopes there is another VTO opportunity to expand this type of work with future FOA's on development of high quality, greener and lower-cost Mg and Mg alloys.

Reviewer 3:

The reviewer said that good collaborations have been engaged to support this project. It was not quite clear to this reviewer how it all goes together, however, and some brief discussion about how the various bits of information generated by the different collaborators fit together to support the program deliverables would be helpful.

Mechanistic-Based Ductility Prediction for Complex Magnesium Castings: Xin Sun (Pacific Northwest National Laboratory) - lm057

Presenter

Xin Sun, Pacific Northwest National Laboratory.

Reviewer Sample Size

A total of four reviewers evaluated this project.

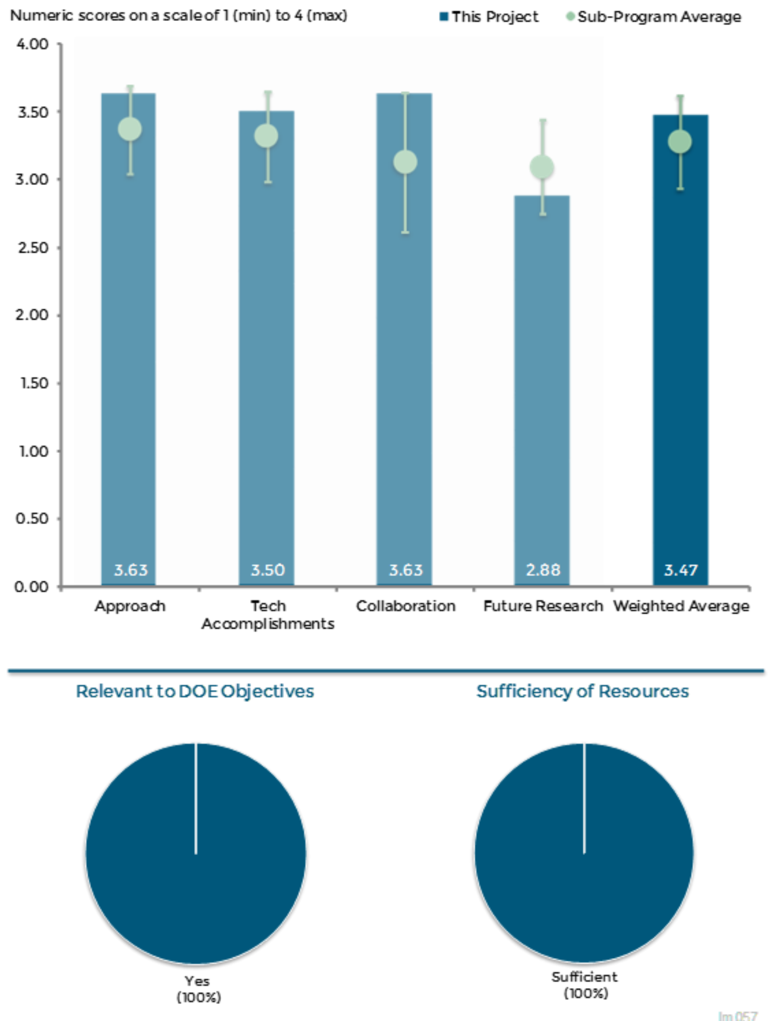

Figure 6-3 Mechanistic-Based Ductility Prediction for Complex Magnesium Castings: Xin Sun (Pacific Northwest National Laboratory) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the approach is impressive and thorough regarding the generalizability of the results as well as gaining a scientific understanding of variables that influence Mg casting quality. The reviewer said nice job.

Reviewer 2:

The reviewer said excellent work, approach is solid. Modeling the complexity of material processing identifies the significance.

Reviewer 3:

The reviewer said that the approach seems very empirical in nature. The reviewer was unsure of the path to widespread use of the findings on castings of different geometry or composition.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer said that the project is complete and outstanding results were achieved.

Reviewer 2:

The reviewer remarked good progress towards modeling a complex manufacturing/material process.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that collaboration was great, and it was good to see original equipment manufacturer- (OEM) involvement at that level.

Reviewer 2:

The reviewer observed very good collaboration.

Reviewer 3:

The reviewer noted that collaboration and cooperation between Pacific Northwest National Laboratory (PNNL) and Ford is apparent.

Reviewer 4:

The reviewer said good collaboration, although the project would gain if all three carmakers were involved.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the project is complete, so no future plans on this project. That said, the reviewer added it would have been good to have a slide on technical transition or barriers to adoption that would have to be overcome, or something similar. The reviewer would have liked a better understanding of the use of the models (as opposed to the approach) to other applications, e.g., military vehicles.

Reviewer 2:

The reviewer said that current research must identify the gaps to conduct future research activities. This type of modeling is in early stages and requires researcher input to go forward.

Reviewer 3:

The reviewer commented that it is not because the project is ending that this kind of work should be stopped. The reviewer opined that it should be extended and generalized to include different Mg alloys, and different casting processes (physical conditions).

Reviewer 4:

The reviewer said that future work is implied (i.e., validate prediction framework), but details are lacking.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer pointed out that accelerating adoption of Mg through the development of analytic tools that predict manufacturing quality will help reduce the weight of automotive structures.

Reviewer 2:

The reviewer remarked that the ability to predict casting ductility (or lack of it) will assist in optimizing component design and thereby minimize weight.

Reviewer 3:

The reviewer said that modeling materials and processes are key to the development of advanced materials and processes.

Reviewer 4:

The reviewer remarked that casting is a fundamental part of the transport industry, and that a better understanding of casting materials can be translated in weight savings.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that the project is complete.

Reviewer 2:

The reviewer remarked that the project is finished, and guessed that resources were sufficient.

Multi-Material Lightweight Vehicles: Tim Skszek (Vehma) - lm072

Presenter

Tim Skszek, Vehma.

Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the approach was excellent to identify state of the engineering art of what is possible regrading multi-material vehicles (MMV), and the reviewer would like to see conclusion slides

Reviewer 2:

The reviewer observed a very good approach, and elaborated that the project is looking at all vehicle systems and reducing the mass wherever possible.

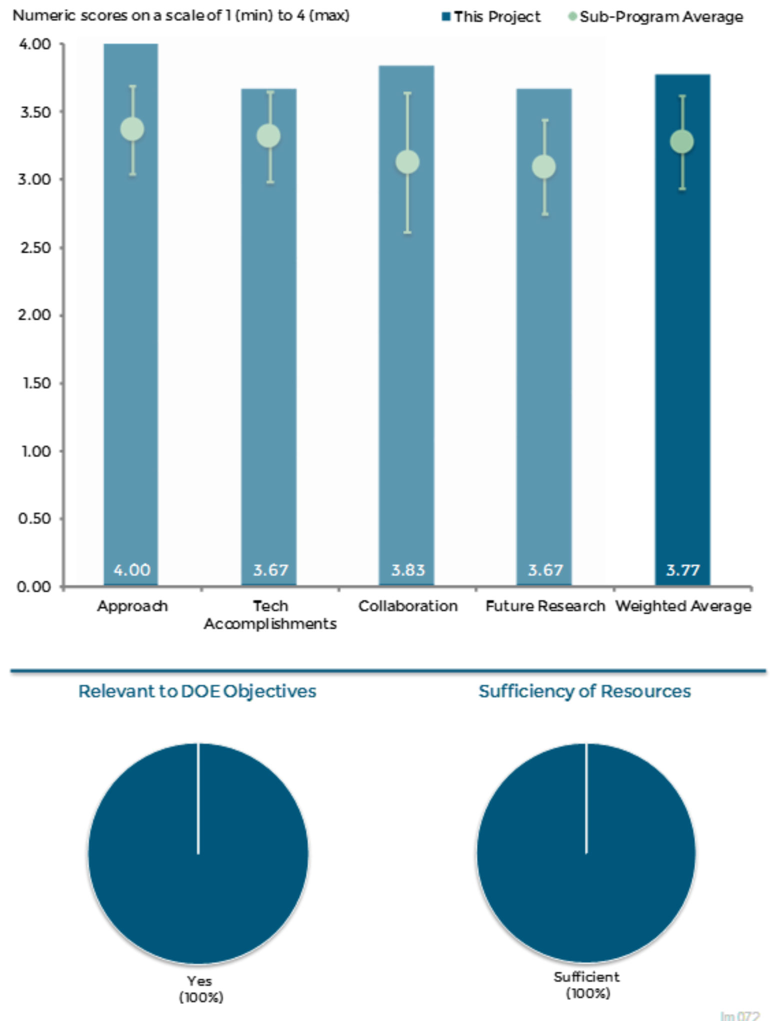

Figure 6-4 Multi-Material Lightweight Vehicles: Tim Skszek (Vehma) – Lightweight Materials

Reviewer 3:

The reviewer identified two approach phases: 24% weight reduction equivalent to a 364 kg weight gain to enabling a smaller engine; and a 50% weight reduction. The reviewer said material optimization is optimizing the best material at the best place, which is very challenging.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer commented that the testing of the Mach I vehicle results is extraordinary, and offered congratulations to the team.

Reviewer 2:

The reviewer emphasized that it is very impressive to have been able to demonstrate so many lightweighting concepts in test worthy vehicles in such a short period of time. However, this reviewer does not feel the project did much to overcome the technical barriers to high-volume production for the industry at large. The reviewer believed the original FOA sought a 50% mass reduction while maintaining the comparator vehicle functionality. The reviewer pointed out that to hit the 50% mass savings even in the hypothetical Mach II much content and functionality had to be eliminated.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that collaboration between Ford and Vehma was clearly strong and effective as well as with all the suppliers.

Reviewer 2:
The reviewer said that collaboration and cooperation between Ford and Vehma is obvious throughout.

Reviewer 3:
The reviewer understands that Ford did not want to share findings of this project with others, but the reviewer thought Ford would have gained if the other two OEMs had been involved.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer commented that the project provides a good list of areas for future research even though the project itself has been completed.

Reviewer 2:
The reviewer noted that the project is ending and the reviewer does not know whether DOE will fund more of this; the reviewer thinks DOE should continue funding but on a broader scale.

Reviewer 3:
The reviewer pointed out that Slide 20 identifies the gaps for the body in white (BIW) and is pretty good (drivers of the gaps would be helpful). The reviewer commented that unfortunately, the vehicle gaps as identified on Slide 25 are a bit vague and general, and mentioned that there were no cost or performance targets. The slide content focused on general technologies (materials, joining, and corrosion) without mentioning specific applications. The reviewer suggested a table of major gaps by specific vehicle subsystem with current performance versus required performance targets.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer remarked outstanding project that demonstrates the state of the art in integrated vehicle lightweighting and current limitations.

Reviewer 2:
The reviewer commented that showing the difficulty in actually producing a commercializable 23.5% lighter vehicle underscores the reality that lightweighting is not easy or inexpensive. According to the reviewer, the project demonstrates technologies in a way that may entice all manufacturers to implement the demonstrated technologies sooner rather than later.

Reviewer 3:
The reviewer pointed out that every time you can eliminate some weight, you use less petroleum.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the project managed to get to the end, so the reviewer guessed the funding was sufficient, although, for a project of that magnitude, it seemed to this reviewer that it was barely sufficient: more funds would have been better.

Reviewer 2:

The reviewer commented that the project is essentially over.

Reviewer 3:

The reviewer said that while $10 million initially seemed insufficient to do what was required by the FOA, it is not obvious how much additional funding would have contributed to further reduction in the mass demonstrated or in the Mach II design. The reviewer therefore concluded that the funding level was sufficient.

SPR Process Simulation, Analyses, and Development for Magnesium Joints: Elizabeth Stephens (Pacific Northwest National Laboratory) - lm074

Presenter

Elizabeth Stephens, Pacific Northwest National Laboratory.

Reviewer Sample Size

A total of three reviewers evaluated this project.

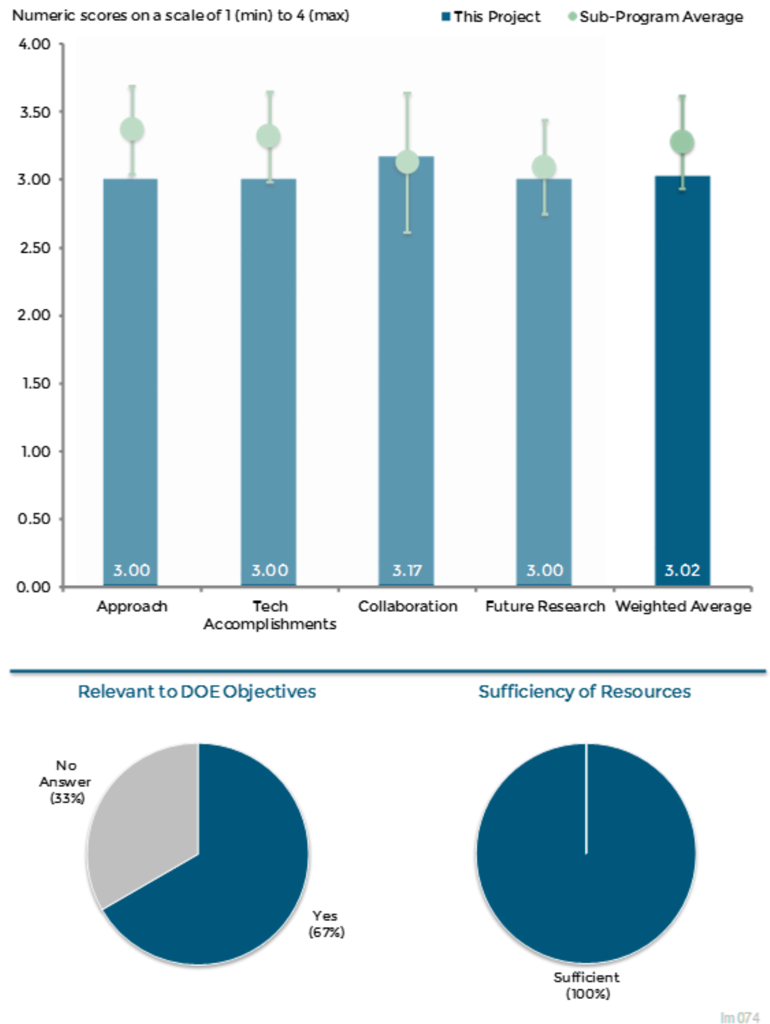

Figure 6-5 SPR Process Simulation, Analyses, and Development for Magnesium Joints: Elizabeth Stephens (Pacific Northwest National Laboratory) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed very solid applied engineering, simulation, and validation work. The reviewer applauded the work, noting that it solved a problem that was of commercial importance to a particular industry/company.

Reviewer 2:

The reviewer believed the work is somewhat off target. For example, focusing on being able to simulate the loads necessary to drive the rivet is of interest but of limited value. The reviewer noted that the ability to simulate the lap shear strength of the rivet joint could be very valuable, but until the accuracy of those simulations can be validated they are of little value. Similarly, testing for fatigue life of the joints is interesting, but according to the reviewer what is really needed is a modeling tool that could accurately predict the fatigue life.

Reviewer 3:

The reviewer commented that in spite of the text on the slides, the reviewer was puzzled as to why rivets are of development importance. The reviewer did not see why rivets are essential other than being a cheap joining method.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer commented outstanding end to a successful project. This is exactly the kind of work that needs to be done: transferring advanced technology into commercial industry.

Reviewer 2:
The reviewer remarked that the work that was accomplished seems to be of little value outside of this project.

Reviewer 3:
Clearly, according to this reviewer, the work was well conducted and the authors delivered what was expected.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that partnership with commercial industry was very successful.

Reviewer 2:
The reviewer said that it appeared Stanley has been involved throughout the project but it is unclear as to what Stanley has contributed. The team lacks a supplier that is capable of developing a commercial system that is viable for high volume automotive production.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the project is complete, including the technology transition

Reviewer 2:
The reviewer said that it is good to see that Stanley is generally supportive of the results of this work and in exploring automation of the heating process. The future research areas articulated in the presentation are rather general and difficult to assess, although the general direction appears to be sound.

Reviewer 3:
The reviewer said that the project is almost over and the reviewer hoped there would be no more of this unless it can be unambiguously shown that there is no other way.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that successful commercial technology for joining lighter-weight materials such as Mg will benefit the adoption of these materials into automotive applications.

Reviewer 2:
The reviewer said that this could enable joining Mg to other components thereby increasing the use of Mg and reduction of vehicle mass.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that the project is complete.

Understanding Protective Film Formation by Magnesium Alloys in Automotive Applications: Mike Brady (Oak Ridge National Laboratory) - lm076

Presenter

Donovan Leonard, Oak Ridge National Laboratory.

Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

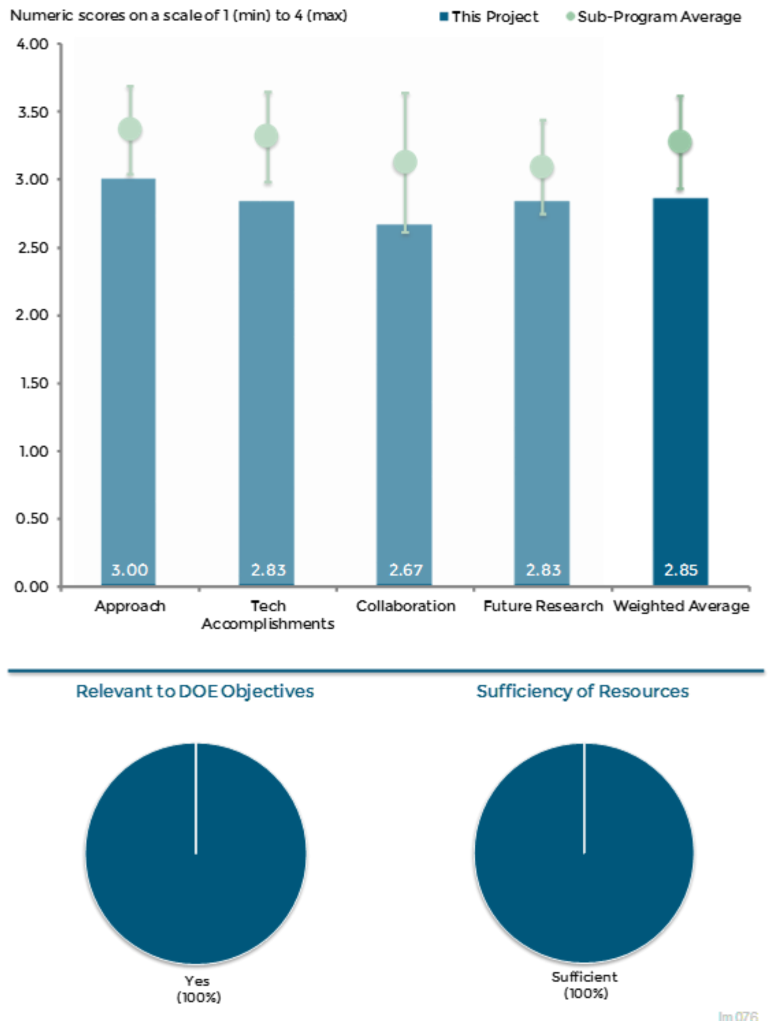

Figure 6-6 Understanding Protective Film Formation by Magnesium Alloys in Automotive Applications: Mike Brady (Oak Ridge National Laboratory) – Lightweight Materials

Reviewer 1:

The reviewer said that understanding Mg corrosion is an important aspect for improving the materials acceptance for structural applications. This project is aimed to develop knowledge about the oxide formation on surface of Mg. The reviewer said that the approach to study bare and coated samples and different alloys is very useful in understanding the interplay of different elements.

Reviewer 2:

The reviewer detailed that the basic science approach to understand the issues surrounding Mg corrosion mitigation coatings is the right approach for this project. The investigators have shown flexibility and creativity in the investigations.

Reviewer 3:

The reviewer noted that the presenter stated (three times in fact) that this study was intended to be a basic science study and was not intended to develop engineering data. In this reviewer’s view, this is the wrong way to approach a study that is part of a program dedicated to reducing the weight of on-road vehicles over the next decade or two. The reviewer commented that in essence, the production of engineering data is not a bad thing and in fact, given the timescale required for new materials introductions into large scale automotive manufacturing, this reviewer perceives that such data is of prime value to the achievement of the DOE objectives.

The reviewer suggested that perhaps this study, which appears to be work of a highly qualified team, would be more suitable as part of a discovery research program such as that conducted as a matter of course by the National Science Foundation (NSF). Perhaps this perception of a lack of weight placed on commercialization is not accurate, but that is the impression conveyed during the talk.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer said that the work certainly appears to be of good or high quality and it would appear that a good deal of basic scientific data has been produced.

Reviewer 2:

The reviewer said that the project continues to make steady progress in understanding film formation on coated and bare Mg. The investigation on two automotive alloys gives direct input to future corrosion mitigation strategies in the automotive industry. The reviewer noted that the investigations of the commercial coatings is interesting but the results are not well integrated into the study. The reviewer suggested that perhaps results should help set direction of the remaining studies.

Reviewer 3:

The reviewer observed that the measurement of hydrogen (H) uptake due to different elements is very interesting. However, effect of elements such as iron (Fe), copper (Cu) and nickel (Ni) on the corrosion of Mg has been very well understood for a long time. The reviewer asked what the relationship is of the current findings to the old knowledge.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that the project team has expanded to include key suppliers of coatings and Mg components. The reviewer applauded that these are great additions to the team. The collaboration between the university investigators, the Mg supplier, the coatings company and the automotive Tier 1 parts supplier shows an excellent team and an appreciation for the complexity of solving automotive problems in light weighting.

Reviewer 2:

The reviewer noted that the project is basic research, and it is good to see that many characterization methods are being evaluated to study the surface oxidation. The reviewer noted that Mg is highly unstable and the operational difficulties are well documented.

Reviewer 3:

The reviewer commented that very little was said beyond a simple listing of partners about the tasking or budget split-up or any of the other key aspects of collaboration, and according to the reviewer it is just about impossible to assess how well that aspect of the project is working.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that plans to complete the project on time are solid.

Reviewer 2:

The reviewer observed that there seemed to be a good plan going forward, although the presentation was so heavy on scientific data and micrographs, that actual project performance data and forward planning was scant.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that Mg is one potential material to achieve significant lightweighting in cars and trucks. The issue of corrosion mitigation is one of the barriers inhibiting the use of Mg components in automotive applications

Reviewer 2:

The reviewer commented that even though it is a very long shot, the basic understanding of the Mg corrosion process can influence development of protection methods. Eventually this will enhance the use of Mg alloys.

Reviewer 3:

The reviewer said yes, it will eventually make an impact, but according to the reviewer the presenter was unable to give any sort of explanation of when or how that might occur.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer pointed out that the cost of the PI at $450,000 per year seems high.

Reviewer 2:

The reviewer emphasized that virtually nothing at all was said about the budget or any of the other project performance data, so this reviewer really cannot comment on resources.

Magnesium-Intensive Front End Sub-Structure Development: Jim Quinn (United States Automotive Materials Partnership) - lm077

Presenter

Jim Quinn, United States Automotive Materials Partnership (USAMP).

Reviewer Sample Size

A total of three reviewers evaluated this project.

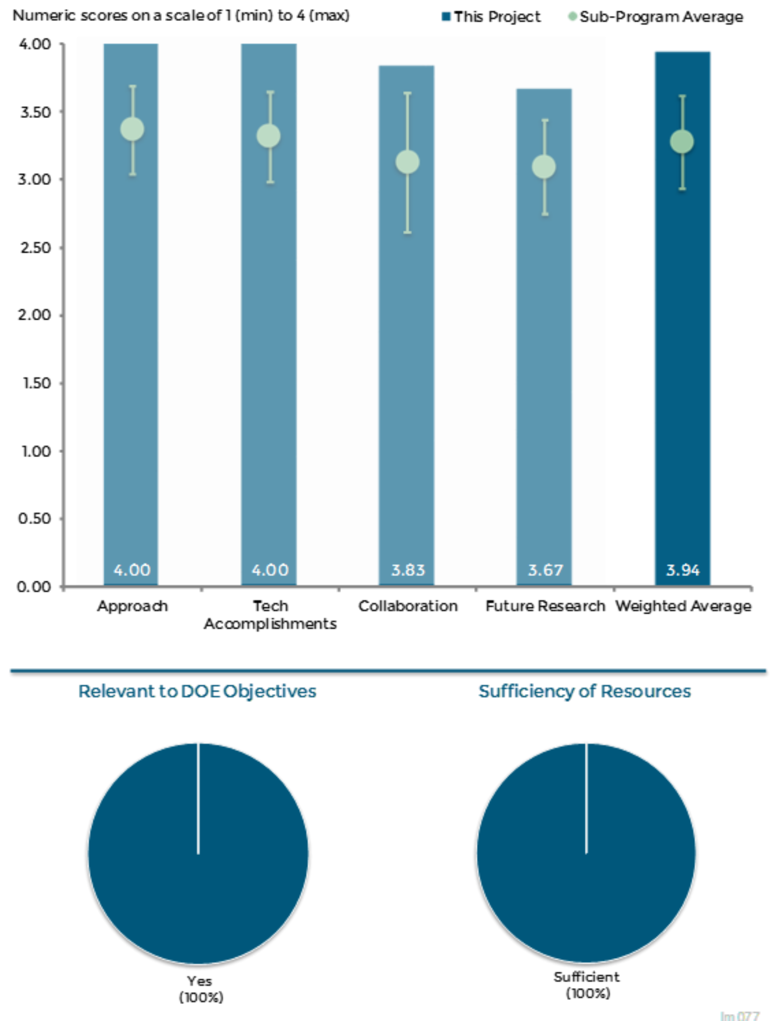

Figure 6-7 Magnesium-Intensive Front End Sub-Structure Development: Jim Quinn (United States Automotive Materials Partnership) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that as noted elsewhere, this is a very complex project that is actually nine separate tasks, and yet, it is has resulted in a tangible progress and so the overall approach must be commended as outstanding.

Reviewer 2:

The reviewer said outstanding approach, 45% weight reduction with respect to steel (which steel), and a 20% weight reduction with respect to aluminum (which aluminum). The reviewer also observed a thorough process, and remarked outstanding international project

Reviewer 3:

The reviewer said complex approach to a technically challenging problem. Not clear from approach how integrated computational material engineering (ICME) is working out and integrating together as a system. The reviewer commented thank you for adding the tasks numbers to Slide Five from last year.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer said that accomplishments are outstanding. Test results are promising and showing areas of success as well as continued challenges. The reviewer noted a lot of good data that should be broadly shared, specifically with TARDEC and Army Research Lab (ARL).

Reviewer 2:

The reviewer said that the work reported upon would appear to be an outstanding contribution to progress toward much lighter vehicle structures. The project is actually nine separate tasks integrated into actual hardware demonstrators of representative automotive structures, so this is an exceedingly complex piece of work involving a very large number of partners and three countries, clearly not an easy task.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that the reported collaboration within the project team appears to be very effective, efficient and collegial. The reviewer enthusiastically exclaimed well done on this particular aspect of the work on this complex piece of work.

Reviewer 2:

The reviewer said that collaboration is excellent.

Reviewer 3:

The reviewer pointed out that managing such a large team must have been quite challenging.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the present project is reported to be 90% complete at this point in time (June 2015) and this reviewer takes that view that the future research directions discussed really refer to projects that are yet to be fully defined. Nonetheless, according to this reviewer the remaining tasks appear to be on-track and everything should be wrapped up by the end of calendar year 2015.

Reviewer 2:

The reviewer said that the project is finishing up and the future work slide focused only on the tasks to be performed within this project (which is appropriate). The reviewer would like to see the following in the final report: barriers that still exist within the test structure with respect to the specific design, material, manufacturing and joining techniques. The reviewer would also like a statement as to the applicability or the limitations of the technologies investigated to other vehicle areas. Finally, the reviewer would like a table or other representation of the technologies, problems, application areas (gaps) and performance metrics (current versus required) for Mg.

Reviewer 3:

The reviewer said that the project is over at the end of the year and, regrettably, there appears to be no follow-on.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said the project is clearly identifying the barriers to adopting a lightweight material such as Mg is supportive of the DOE VTO mission.

Reviewer 2:

The reviewer said that the work of this project is definitely very closely aligned with the DOE objectives because it will lead to much lighter vehicle structures.

Reviewer 3:
The reviewer said that the results speak for themselves.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that it was reported that due some unforeseen difficulties, the project has been extended by six months at no cost to DOE, and at present the resources appear to be adequate to permit completion of the work within the new timeframe (by November 2015).

Reviewer 2:
The reviewer said that the project is nearly over, and the project team has sufficient funds to finish.

Reviewer 3:
The reviewer guessed that resources were sufficient, but in absence of a budget, it is impossible to say for certain.

Aluminum Formability Extension through Superior Blank Processing: Xin Sun (Pacific Northwest National Laboratory) - lm078

Presenter

Xin Sun, Pacific Northwest National Laboratory.

Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said end of project, and the approach to the final hole stretching model was straightforward. The reviewer said that overall the project was excellent.

Reviewer 2:

The reviewer observed a good approach in comparing punch clearance to edge cracking.

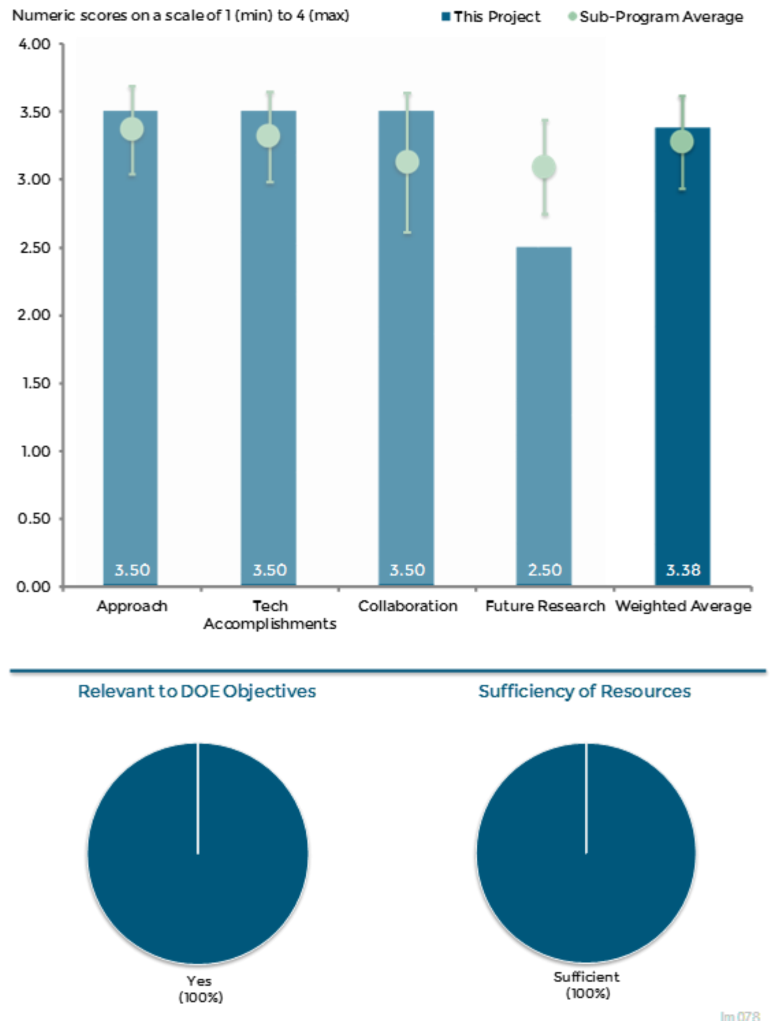

Figure 6-8 Aluminum Formability Extension through Superior Blank Processing: Xin Sun (Pacific Northwest National Laboratory) – Lightweight Materials

Reviewer 3:

The reviewer said that room-temperature formability of an aluminum alloy is a significant barrier. Doll tool result for punching is very interesting, even if it is counter-intuitive.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer said outstanding work, yielding unexpected but validated results.

Reviewer 2:

The reviewer said that the test matrix was executed and results were obtained.

Reviewer 3:

The reviewer noted that very significant results were obtained, and the reviewer would have liked to see other thicknesses to test the viability of the scalability.

Reviewer 4:
The reviewer said end of project, the resulting model predicted surprisingly well.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that collaboration was limited, focused, well-coordinated, and well executed. The reviewer said that it was difficult to see who else was missing or needed.

Reviewer 2:
The reviewer observed very good collaboration between an OEM, university and a DOE national laboratory.

Reviewer 3:
The reviewer noted that there appeared to be extremely close linkage with the partner organizations, particularly Ford. The reviewer did not give the project a full 4.0 rating only because there are few participants involved, which makes coordination an easier task.

Reviewer 4:
The reviewer would have liked to see a broader collaboration.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that future research is in the proposal phase, and focusing on implementation and cost reduction, which is always a good area to focus on after successful research. The reviewer said that how the project team will go about doing it will make all the difference. The reviewer would prefer to see some statement as to the extent the basic work should be expanded (e.g., other alloys, etc.).

Reviewer 2:
The reviewer pointed out that there is no application demonstration planned.

Reviewer 3:
The reviewer noted that the project is ending, and asked should that kind of work be extended.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that anything that increases the application of aluminum in place of conventional steel will greatly assist in vehicle lightweighting efforts.

Reviewer 2:
The reviewer said that understanding material processing parameters to enable application and acceptance of lightweight material is one key to commercial use and application of lightweight materials.

Reviewer 3:
The reviewer detailed that improving performance of forming processes for lightweight materials lowers the barrier for adoption. Developing a fundamental understanding of the process and having a simulation model available will allow companies to optimize their processes for their products. The reviewer said that anything to lower the adoption of new lighter-weight materials into vehicles will help make lighter weight vehicle commercially successful.

Reviewer 4:
The reviewer said yes, in the sense that the manufacturing would be quicker (and therefore cheaper).

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that the project is complete and successful.

Enhanced Room-Temperature Formability in High-Strength Aluminum Alloys through Pulse-Pressure Forming: Rich Davies (Pacific Northwest National Laboratory) - lm079

Presenter

Rich Davies, Pacific Northwest National Laboratory.

Reviewer Sample Size

A total of three reviewers evaluated this project.

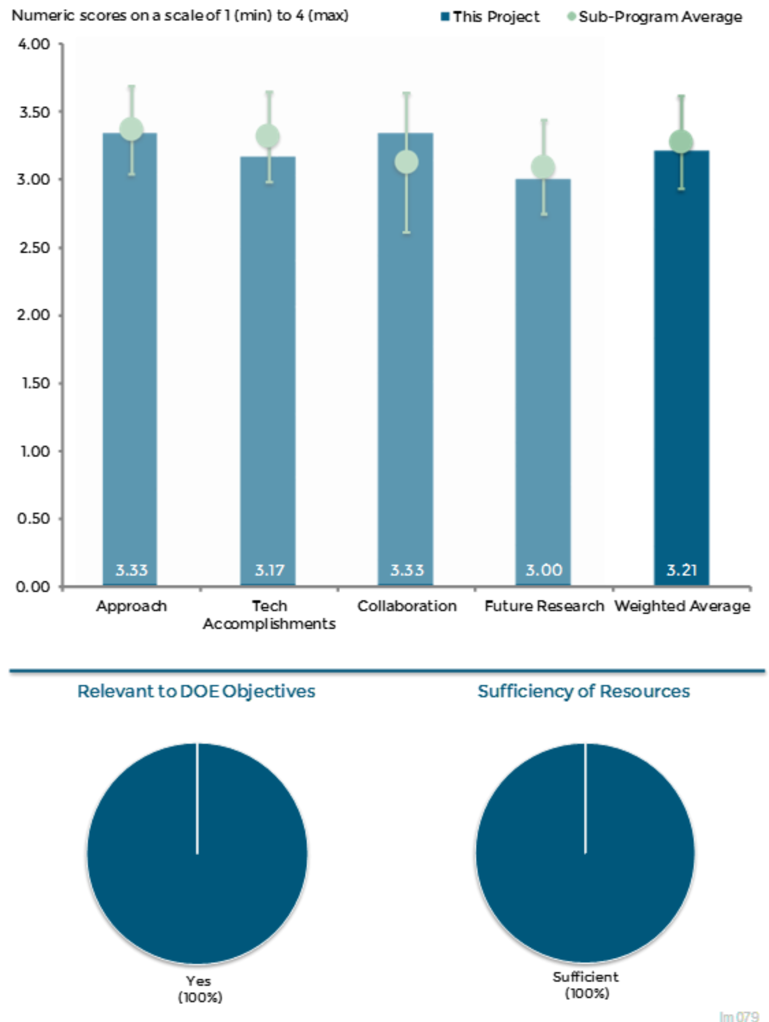

Figure 6-9 Enhanced Room-Temperature Formability in High-Strength Aluminum Alloys through Pulse-Pressure Forming: Rich Davies (Pacific Northwest National Laboratory) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the project is well designed, and is focused on a novel forming process aimed at forming 7xxx alloys at lower temperatures (room temperature is preferable). The reviewer commented excellent use of government-funded hardware (high-speed cameras).

Reviewer 2:

The reviewer said that the approach to address the formability of 6xxx and 7xxx aluminum sheet with both national laboratory-level science and automotive supplier, American Trim and Magna, production minded partners is great. The reviewer said that performing the experiments at PNNL and then investigating commercialization with a supplier is a strong approach to the challenges.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer said that there has been solid progress on the technical areas for this project. Good information on the strain rates during pulse pressure forming. The reviewer said that the decision to only simulate an automotive part is understandable but disappointing.

Reviewer 2:

The reviewer noted that while the project did not succeed in forming a 7xxx part, the learnings derived will be invaluable for future projects aimed at developing methods for producing 7xxx automotive parts at room temperature. The reviewer had one note to help the principal investigators: all graphics need to contain relevant quantitative data. For example, on Slide 4, the forming limit plot has the labels possible high rate and quasit-static. Please quantify all such terms. The reviewer asked if there was a finite element simulation aimed at predicting whether or not a 7xxx part could be formed. The reviewer would like to know why the part making not succeed.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that five partners have been engaged to work on this project with PNNL. The engagement of each appears to have been sufficient enough to help the PIs achieve program deliverables.

Reviewer 2:

The reviewer said great teamwork across the full spectrum of the organizations and automotive supply chain.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer remarked end of the project; no suggestion for future direction

Reviewer 2:

The reviewer pointed out that the project will likely finish on time.

Reviewer 3:

The reviewer said that it appeared that a main barrier to the wider-scale implementation of the pulse-pressure forming method is supply chain. The reviewer asked if the PIs have investigated the reasons why, and if this is related to the fact that 7xxx are primarily aircraft alloys. The reviewer asked where are (is) the weak links (link) in the supply chain. The reviewer concluded that a more thorough investigation is required.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that aluminum 7xxx promises greater vehicle lightweighting if in fact the material can be stamped into body structure components (b-pillars, roof rails, rockers, hinge pillars, a-pillars, one bars, etc.).

Reviewer 2:

The reviewer said that high-strength aluminum is a key material for lightweighting. The forming of high-strength aluminum is one of the challenges facing the material.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that resources are sufficient.

Integrated Computational Materials Engineering Approach to Development of Lightweight 3GAHSS Vehicle Assembly: Lou Hector (United States Automotive Materials Partnership) - lm080

Presenter

Lou Hector, USAMP.

Reviewer Sample Size

A total of four reviewers evaluated this project.

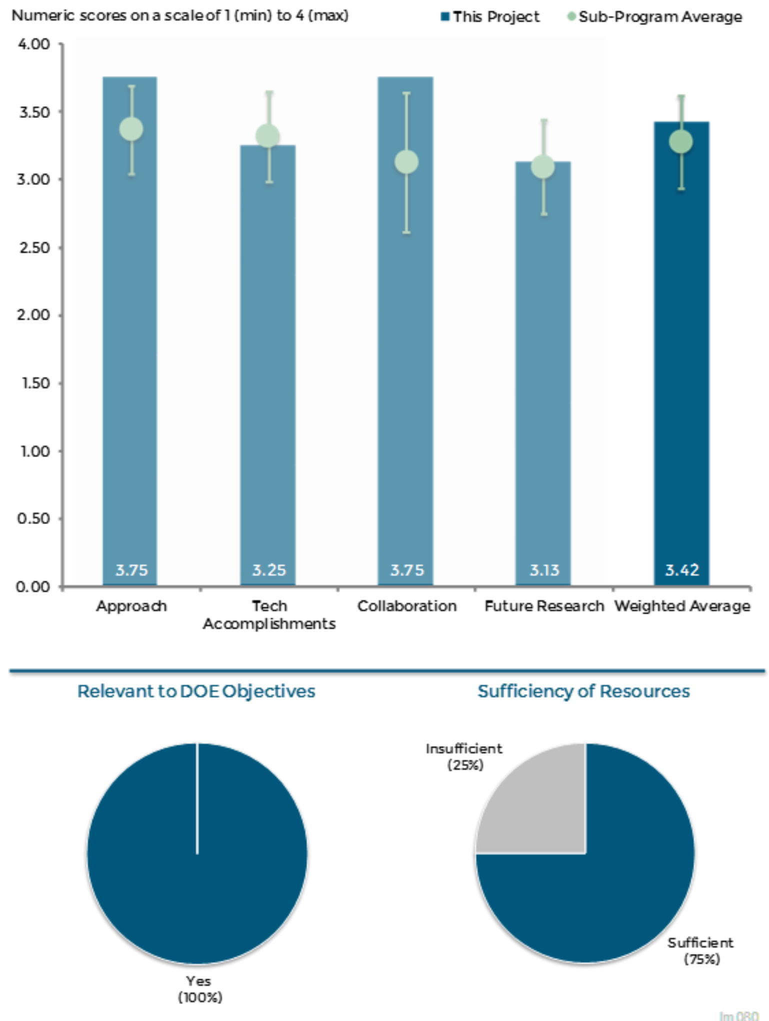

Figure 6-10 Integrated Computational Materials Engineering Approach to Development of Lightweight 3GAHSS Vehicle Assembly: Lou Hector (United States Automotive Materials Partnership) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that this is a very complex project involving a substantial amount of new knowledge and novel experimental technique development. As such, there are a lot of moving parts and the team is encountering significant challenges, some of which are unforeseen and unforeseeable. The reviewer said that the team appears to be working very hard and staking a systematic approach to the planned tasks and to the solution of the problems that are coming up and they are succeeding. The reviewer concluded overall, this is an excellent piece of research & development and a talented and well-integrated team is doing a fine job on it.

Reviewer 2:

The reviewer stated that this project is one of the most ambitious and important projects currently being pursued to determine the utility and efficacy of ICME. It is important because it is using the ICME framework of linking different length scale simulation models (atomistic material though macro product performance) to not only accelerate the adoption of materials (as has traditionally been done), but rather to extract the required material properties from the performance requirements to create new materials; a materials by design approach. The reviewer said that generating and validating the models based on an existing material that is near the desired properties is a good approach. According to the reviewer, but it is still technically difficult and of concern how generalizable the various models are to the new material domain.

The reviewer suggested that the project team please create a slide next time that describes the limitations of the models (chemistry limited, scale limited, thickness limited, process limited, etc.). The reviewer noted that it was mentioned that dislocation models would be necessary, but more generally, putting together a slide that shows the types of factors that have to be experimentally measured each time to validate models or the expected factors that would limit the generalizability of the model.

Reviewer 3:

The reviewer said that the experimental approach and the theoretical work are excellent. The reviewer said that the goal is impressive, but the proposed operation schedule appears to be too optimistic.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer reiterated that there have been significant challenges and they are being overcome as they come up.

Reviewer 2:

The reviewer said that two steel compositions have been identified; even though this is due to the efforts of Colorado School of Mines and steel makers, accepting these as the base alloys is commendable.

Reviewer 3:

The reviewer asked why nothing was reported on the completed cost model. The reviewer wondered are any of the cost factors related to the material models (e.g., chemical composition). In the future this reviewer would like to see the milestone table accomplishments against the milestones for the whole project to judge progress. The reviewer said that a lot of work and progress appears to have been performed on a very complex project.

Reviewer 4:

The reviewer is not yet positive as to whether the team can deliver in the project timeframe, and asked about validation. The reviewer pointed out that austenitic transformation is not yet included in the modeling, coupon size only at the preliminary stage and heat treatment samples are even smaller, and the team will need ingots of about 800-1,000 kg before the team can see the end of the tunnel. The reviewer said that it appears ICME will be a function of size and weight

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that collaboration is outstanding given the number and variety of organizations involved. As expected on a project that involves this level of technical complexity and integration, specialty cross functional task teams have been created

Reviewer 2:

The reviewer said that the work of this large and complex team looks to be extremely well integrated and collaborative.

Reviewer 3:

The reviewer said good team, and noted extensive collaboration.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted there are some tough challenges, but looks good.

Reviewer 2:
The reviewer recommended that the team has to concentrate on obtaining larger ingots.

Reviewer 3:
The reviewer said that it is difficult to assess future work plans without milestone chart and better explanation of where the pieces are going, when specific system level tests or demonstrations are going to be conducted. The reviewer said that the lack of these integrated milestones is part of why risk assessment is relatively weak. For example, a risk that is not addressed is what happens if a major university PI becomes unavailable to the project. The reviewer wondered if this is not an issue. The reviewer inquired if there are sufficient grad students/colleagues who can pick up the work without delay.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The target of 35% weight reduction makes sense and it certainly aligned with DOE’s goal.

Reviewer 2:
The reviewer said that this is an important project for demonstrating how new lightweight materials could be developed using ICME. ICME to date has primarily been used to accelerate adoption of materials into application based on optimizing forming and assembly parameters. The reviewer stated that this project aims to use the process to optimize material parameters.

Reviewer 3:
The reviewer pointed out that stronger material implies less material, resulting in a lighter structure.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
To this reviewer, the funding is clearly insufficient: larger intermediate ingot sizes are pricy and the magnitude of the testing increases with ingot size; there is no way that intermediate sizes can be avoided before obtaining industrial size ingots with the desired physical characteristics. The reviewer stated that DOE should already plan on extending the length of the project. The reviewer recommended that makers of large industrial ingots of specialty materials should be approached and included in such project.

Reviewer 2:
The reviewer said that resources look fine.

Reviewer 3:
The reviewer said that the impact of this project justifies the number of participants and the associated cost. At this time, there appears to be sufficient funding, but the reviewer expressed some concern that later manufacturing costs will be higher and affect the project. This is particularly true if there are any delays/unexpected barriers that require an extension.

GATE Center of Excellence at UAB for Lightweight Materials and Manufacturing for Automotive, Truck and Mass Transit: Uday Vaidya (University of Alabama, Birmingham) - lm081

Presenter

Uday Vaidya, University of Alabama, Birmingham.

Reviewer Sample Size

A total of four reviewers evaluated this project.

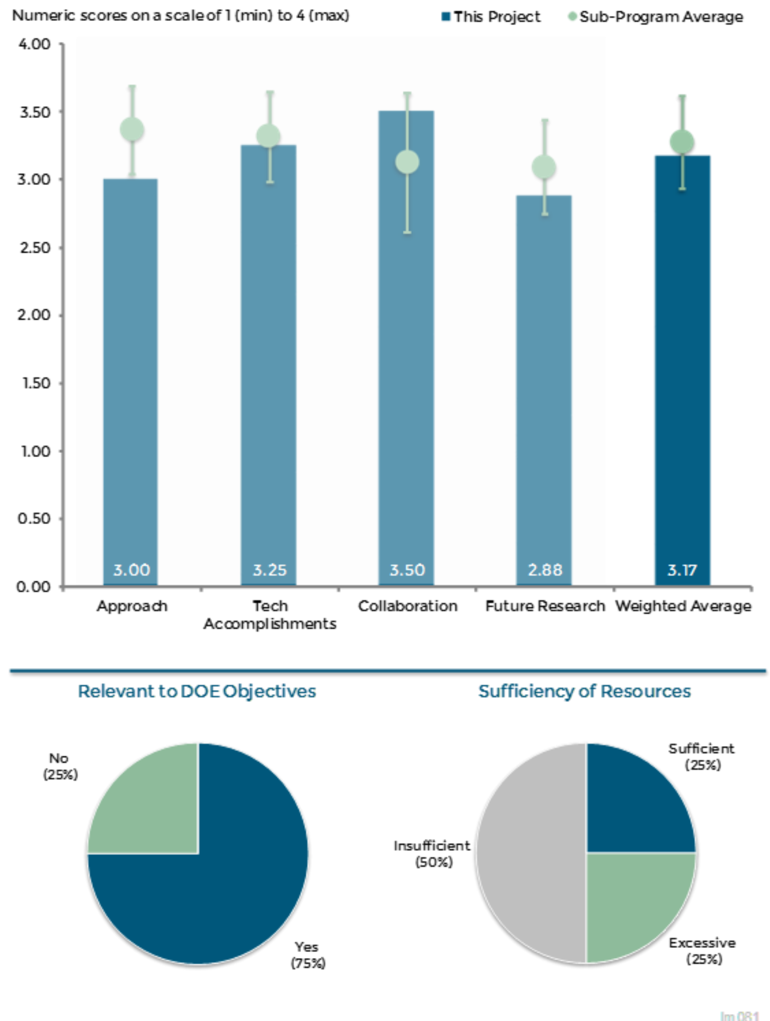

Figure 6-11 GATE Center of Excellence at UAB for Lightweight Materials and Manufacturing for Automotive, Truck and Mass Transit: Uday Vaidya (University of Alabama, Birmingham) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer thinks that GATE is an outstanding formation program and that model of instruction should be exported to other fields of manufacturing.

Reviewer 2:

The reviewer said that it appears the program is effective in educating students in the area of automotive lightweighting materials.

Reviewer 3:

The reviewer described that the rating is a reflection of the presentation and its structure, more than the value of the work. The reviewer is a strong supporter of the effort and believe it is worthy of a 4, but the presentation does not show this. The reviewer thinks that based on the Q&A, this program has been outstandingly managed and the funding has been utilized far better than the presentation suggests. For example, the leveraging of funding and rotation of the students is significant and worthwhile. The reviewer recommended that a slide should show this. This review is very difficult when all the information is in aggregate and not presented as progress since last year. Also, the research projects are presented as disjoint projects. There do not appear to be overriding themes. The reviewer said that this was a problem last year as well. Slide 6 attempts to present a structure, but it is not used at all in the presentation. The reviewer detailed that there are a finite number of students who are presumably working on a series of experiments/projects that lead to new knowledge. While that would be one way to structure the presentation, it is not used. The reviewer acknowledged that the Graduate Automotive Technology Education (GATE) program is undoubtedly very good and useful, but the annual review slides are not helpful in communicating annual progress or future plans.

Reviewer 4:

The reviewer said that the approach appears scattered rather than focused. The reviewer asked what are any documented successes from the center that have been produced in lightweight composites, and what weight savings in automotive components have been produced based on the GATE projects.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer said that the project has trained many students, and held workshops on lightweight metal casting, composites manufacturing, materials selection and recycling. The reviewer said that it is difficult to assess the technical merits of what the workshops accomplished. However, the results of the student efforts appear to be substantial in number and quality. The reviewer concluded that it appears that the program largely accomplished its mission and objectives for the year.

Reviewer 2:

The reviewer said that the accomplishment on supporting a handful of students is acknowledged but there is no indication of advancing the state of the art. The reviewer asked what the advancements are that have been born at GATE.

Reviewer 3:

The reviewer said no change in the education course developed from 2014 to 2015 according to the slides, but the speaker claimed that two courses were new. The reviewer requested please make this clearer. The speaker talks in terms of course development since inception, which was four years ago. The reviewer would also like to have graphs of student attraction, retention, and graduation over time by year, and not in total. The reviewer was unclear about how the research projects are developed and selected or transitioned. There are a variety of research projects integrated with an educational program in automotive lightweighting, and for the reviewer it was difficult to assess how the research projects fit together, if at all.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that there are indications of regular and strong interactions with several industrial and educational organizations.

Reviewer 2:

The reviewer said that the University of Alabama is at the center of a large pool of carmakers: they are in a unique position.

Reviewer 3:

The reviewer gave kudos to the team for engaging both community colleges, Oak Ridge National Laboratory (ORNL), and industry. The reviewer was happy to see that this year's presentation more clearly presented where the students are going and what they are doing. The reviewer offered congratulations. The reviewer suggested perhaps putting in a table information such as percentage of students in the program working in other organizations, hired, interning, or other interactions. The reviewer suggested presenting a slide tracking graduates, or plans to do so. The reviewer inquired if the first graduate was in 2013. If not, that graduate should be surveyed in 2015 (three years later).

Reviewer 4:

The reviewer commented fair; there is little evidence of the purported collaborations. This reviewer had hoped to see examples of projects with industrial partners in which the contribution of the center was clear.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said the plan to the end of the project is good and should be continued.

Reviewer 2:

The reviewer would like to see more how the future plans fit together over time in fiscal years 2013, 2014, and 2015. The reviewer would like to see ideas on program sustainment past DOE funding. There must be some rationale to the projects that are pursued, even if the funding sources are mixed. The reviewer suggested showing a matrix of projects over time with percent of funding source (if mixed/ necessary) by year grouped by theme or overarching strategic goal.

Reviewer 3:

The reviewer said that the description of future work appears to be too general.

Reviewer 4:

The reviewer said that proposed future research is poor, the center appears to be hoping for more industrial projects.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said yes, and detailed that increasing the number of engineers capable of designing and manufacturing automotive systems with new lightweight materials contributes to the commercial adoption of these materials the DOE goal of lightening vehicles to decrease petroleum use.

Reviewer 2:

The reviewer said that teaching our future engineers and researchers how to manufacture and work with these lightweighting materials is crucial for rapid and widespread application of the materials in vehicle lightweighting.

Reviewer 3:

The reviewer said yes, because the students learn how to use light materials

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer was actually impressed with the amount of research being conducted and the number of students being supported for the amount of funding. The reviewer concluded very good investment. Additional funding would presumably increase student participation and grow the program. The reviewer is concerned that without a plan for future sustainment without VTO funding, the investment may be lost. The reviewer recommends a one-year extension with funding to ensure the future long term success of the program (if necessary).

Reviewer 2:

The reviewer said that resources appear sufficient for current level of activity. However, it would appear appropriate and desirable to increase funding to be able to expand the program further.

Reviewer 3:

The reviewer qualified the response given about resources by stating but they could do more with more funding and that would be for the benefit of the entire country.

Reviewer 4:

The reviewer questioned the return on investment for this program.

Validation of Material Models for Automotive Carbon Fiber Composite Structures: Libby Berger (General Motors) - lm084

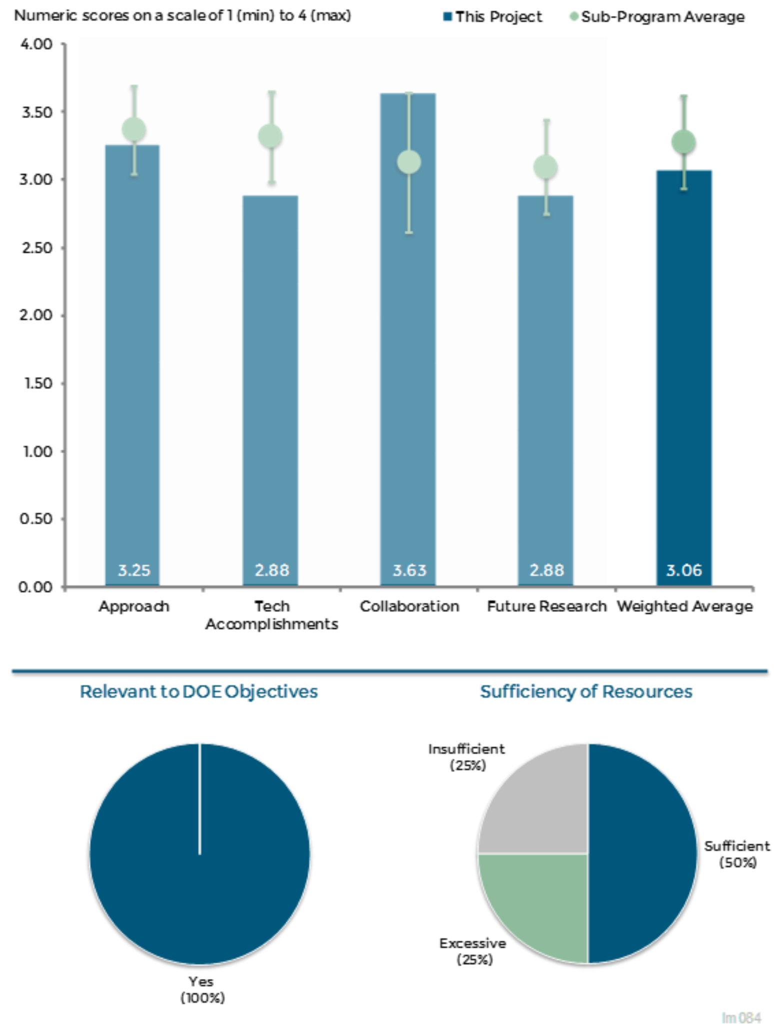

Figure 6-12 Validation of Material Models for Automotive Carbon Fiber Composite Structures: Libby Berger (General Motors) – Lightweight Materials

Presenter

Omar Faruque, Ford.

Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed good comparison between steel front bumper and crush can (FBCC) and composite FBCC.

Reviewer 2:

The reviewer said that the project objectives are focused on engineering, analysis, manufacturing and component-level validation testing a functional automotive component.

Reviewer 3:

The reviewer said that establishing the steel benchmark was an outstanding method for controlling geometry effects and determining the acceptable simulation validation range. The reviewer recommended a slide that more clearly shows the thought process behind the validation tasks, i.e., steel design to determine validation limits, competing models, limitations of the competing models, etc. The slide could also present how the project will identify gaps in carbon fiber composite (CFC) modeling. The reviewer would also like to see a statement that more clearly addresses the expected limitations of the models. Are the models highly geometry dependent, load sensitive, material limited, etc. The reviewer asked what the anticipated applicability is of the models only for the structure shown, similar bumper structures of the same materials, other structures that have certain characteristics, and what are these characteristics.

Reviewer 4:

The reviewer said that the approach to performing the work is too broad and does not describe integration of key activities that are needed for the successful outcome of the project. There also needs to be additional thoughts given to the details of CAE correlation plan, and the key factors that can contribute to successful correlation activities. The reviewer observed that very little content was shown on the development techniques used for composite bumper beam design and assumptions that were made to derive the details of the concept design.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer said that the project is significant and well thought out. Milestones are logical and one can see how they build on each other. The reviewer noted an acknowledgement of a slow project start, but apparently no impact on schedule.

Reviewer 2:

The reviewer detailed that much of the presentation material covered the approach versus showing key outputs from the conducted studies. No reference was made towards to details of characterization techniques used to generate the needed parameters for CAE material inputs. The reviewer said that if coupon level experimental data has been generated, then there was an opportunity to identify the gaps of the existing commercial codes and university developed modules against coupon level experimental data while waiting for the testing of fully assembled bumper beam components.

Reviewer 3:

The reviewer listed the following: correlate physical properties; compression molding for fabrication; establish reliability gap because strength for composite FBCC seems to be an issue; and corrosion between CF bumper and frame was not considered at this time, but should be done.

Reviewer 4:

The reviewer said that the 2015 progress report versus 2014 report lacks significant progress.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented large pool, and good members.

Reviewer 2:

The reviewer acknowledged an outstanding collaboration slide. Each subcontractor has a clear task in the project. The reviewer was still unclear how the meso-scale and micro-plane representative unit cell models are integrated/work together when they are developed by two different teams.

Reviewer 3:

The reviewer concluded that coordination with different partners appears reasonable. The reviewer said that contributions from ESI are not very clear. Coordinating CAE model development and testing with University of Michigan and Northwestern are not clear. The reviewer said that possible integration of university-developed codes with commercial software were not reflected. The reviewer said that coordination with validation of material models was not reflected in the plan.

Reviewer 4:

The reviewer said that although the number of participants and degree of collaboration is very good, it may also be the source of the lack of progress.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the project is in good hands. Final results may be limited by the present funding.

Reviewer 2:

The reviewer said that future plans are logical, low-risk, and effective at achieving project goals. The reviewer suggested that thought should be given to more systematically formulating the robustness of the models, specifically, their sensitivity to changes in system factors (e.g., materials, geometry, energy, and dynamics speed). For example, the reviewer asked about the likeliness of any model to be able to extrapolate to military-like high strain rate events.

Reviewer 3:

The reviewer explained that because not much result was shown on CAE correlation activities at a coupon or component level, it is unclear whether the project team has a plan in place to address the critical issues that the team may run up against in the full bumper beam assembly.

Reviewer 4:

The reviewer said that future research is not articulated in the 2015 AMR report. The significance of this project is to correlate predictive material models to actual test results. The research plan does not articulate a plan to deliver the Project Objectives. The reviewer said that there was no discussion regarding non-destructive testing.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that vehicle lightweighting is one of the key technologies for improving vehicle fuel efficiency. Understanding how composite structures behave in high-strain rate events and being able to model that behavior is a requirement to ensure commercial adoption of this lightweight material.

Reviewer 2:

The reviewer indicated that an assessment will identify the gaps in predictive capability.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that the team has sufficient funding for the composite structure build and test.

Reviewer 2:

The reviewer observed sufficient resources, and recommended better emphasis on the efficient planning of key activities towards key objectives of the program.

Reviewer 3:

The reviewer believed that the project is too skimpy on testing.

Collision Welding of Dissimilar Materials by Vaporizing Foil Actuator: Glenn Daehn (Ohio State University) - lm086

Presenter

Glenn Daehn, Ohio State University.

Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed an interesting and very thorough approach to determine what influences the process and to quantify its influence on strength and corrosion.

Reviewer 2:

The reviewer commented innovative project that can have great outcomes for the car industry and others. Vaporizing foil actuator welding is a technology with great promise. The reviewer also said joining dissimilar material.

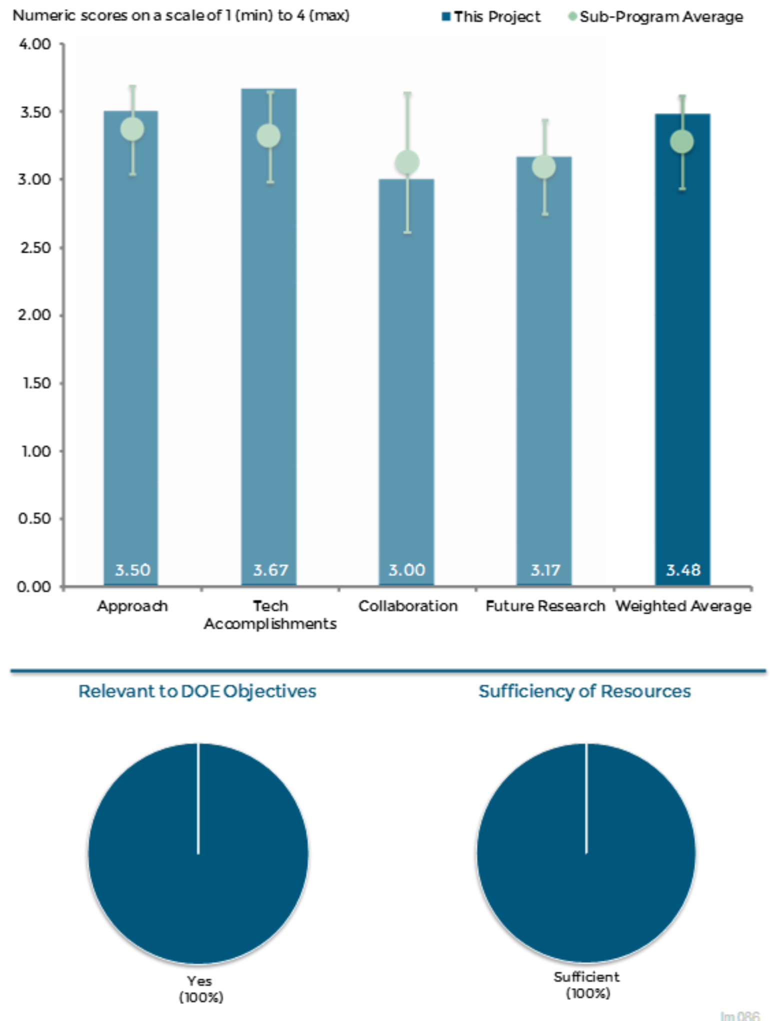

Figure 6-13 Collision Welding of Dissimilar Materials by Vaporizing Foil Actuator: Glenn Daehn (Ohio State University) – Lightweight Materials

Reviewer 3:

The reviewer found that the approach is solid, with a screening study of 15 mixed material combinations and then a focused study on six combinations. The reviewer said that it is okay to focus just on flat welding

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer said that the PI provided information showing excellent progress.

Reviewer 2:

The reviewer noted that collision weld is material transfer into each other, and that corrosion testing in progress. The reviewer pointed out that peel strength in joint is greater than in material, and appears to be a very robust process.

Reviewer 3:

The reviewer said that the progress is good, but the rate of progress is a bit in question given the few months remaining before the end of the project. The corrosion testing will further inform the future value of this method. The reviewer said that the need for a standoff gap appears to be problematic in automotive design. The reviewer suggested please look more at the fixturing and with the urethane washers to create the standoff. The reviewer said that these would be difficult to include in high-volume processing.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that it appears collaborators have primarily provided opinions and guidance, rather than shared responsibility for the research. Therefore, not much coordination was evident (or needed).

Reviewer 2:

The reviewer said that there was little interaction with a supplier to commercialize this process, and hopefully Johnson Control will help in the next years.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said solid plan to wrap up the project.

Reviewer 2:

The reviewer said that it is hard to ascertain what will be done in this project as opposed to what someone should do.

Reviewer 3:

The reviewer said that the project is close to the end, and asked if DOE intends to pursue such work.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that enabling material replacement with a lighter one makes a lot of sense.

Reviewer 2:

The reviewer said that mixed material joining is a key enabler for many lightweight vehicle scenarios.

Reviewer 3:

The reviewer said that this provides a new approach to join dissimilar lightweighting materials for vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

There were no reviewer comments on resources.

Active, Tailorable Adhesives for Dissimilar Material Bonding, Repair and Assembly: Mahmood Haq (Michigan State University) – lm087

Presenter

Mahmood Haq, Michigan State University.

Reviewer Sample Size

A total of three reviewers evaluated this project.

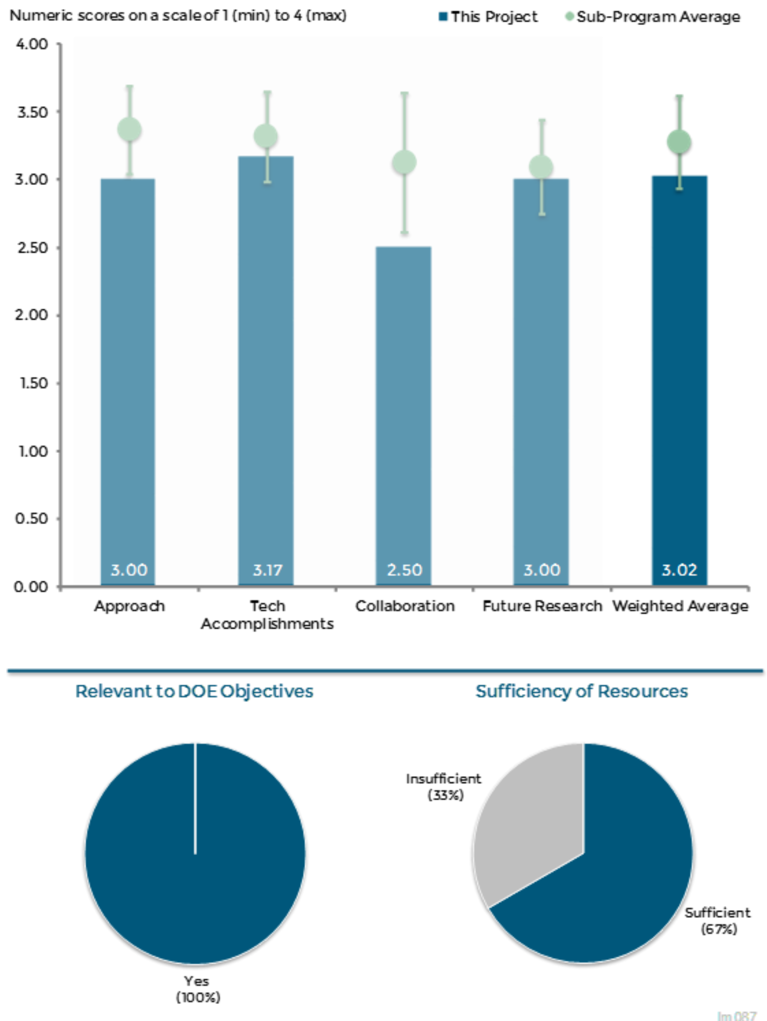

Figure 6-14 Active, Tailorable Adhesives for Dissimilar Material Bonding, Repair and Assembly: Mahmood Haq (Michigan State University) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented excellent use of graphene in the approach and praised the mechanism for assembly and de-assembly as excellent and timely.

Reviewer 2:

The reviewer expressed that this is a very good approach to an interesting technical concept.

Reviewer 3:

The reviewer judged that the approach as not clearly appropriate for this study and questioned exactly how the investigators will use a rational computational materials approach to advance this study. The reviewer observed that no evidence is given in this presentation, and said that there is an apparent random walk rather than a directed approach.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer praised the progress from year one to year two as remarkable, citing the successful assembly and de-assembly as a great feature of this project.

Reviewer 2:

The reviewer applauded solid, valuable accomplishments and acknowledged the active sites identified in the adhesive chemistries as a valuable addition to the state of the art. The reviewer offered that improvements in the lap-shear strength by 3% to 5% graphene nanoplatelets (GnP) to nylon is a good accomplishment.

Reviewer 3:

The reviewer cited good results but offered it would be better to use an adhesive other than nylon, because the auto industry makes only limited use of nylon due to its affinity for moisture.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer acknowledged existing collaborators/partners appeared to be engaged and recommended that the team should also include at least one automotive OEM and an adhesive supplier.

Reviewer 2:

The reviewer indicated that the planned work with Eaton sounds good and recommended more interaction and cooperation with the adhesive suppliers.

Reviewer 3:

The reviewer indicated an understanding of the reserve that the team has maintained and suggested that this project would gain acceptance if it had more partners.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer liked the way the project is advancing and hopes the present momentum can be maintained to the end of the project.

Reviewer 2:

The reviewer commented that the planned work with Eaton sounds good.

Reviewer 3:

The reviewer stated that the project team seems to have a good understanding of technical hurdles and cautioned to not simply assume that what the team learns will apply to other adhesives, further recommending the research should move away from nylon and focus on adhesives to be specified by automotive representatives.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer affirmed that an adhesive that could be easily disbonded or refreshed under carefully controlled conditions would be a boon to assembly of dissimilar lightweighting materials, pointing out that it is difficult or impossible to use more conventional joining techniques for assembling many lightweight material combinations, and concluding this could speed more rapid implementation of lightweight materials.

Reviewer 2:

The reviewer noted that enabling the bonding of fiber reinforced composites to metal and/or composite will get to lighter structures than presently achieved.

Reviewer 3:

The reviewer confirmed that joining of composites to steels and Al is a key enabler for lightweight designs.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated resources were insufficient, recommending the team should include the current car industry participation and also add other industries where bonding is a significant part of their businesses.

High-Strength Electroformed Nanostructured Aluminum for Lightweight Automotive Applications: Shiyun Ruan (Xtalic Corporation) - lm089

Presenter

Shiyun Ruan, Xtalic Corporation.

Reviewer Sample Size

A total of four reviewers evaluated this project.

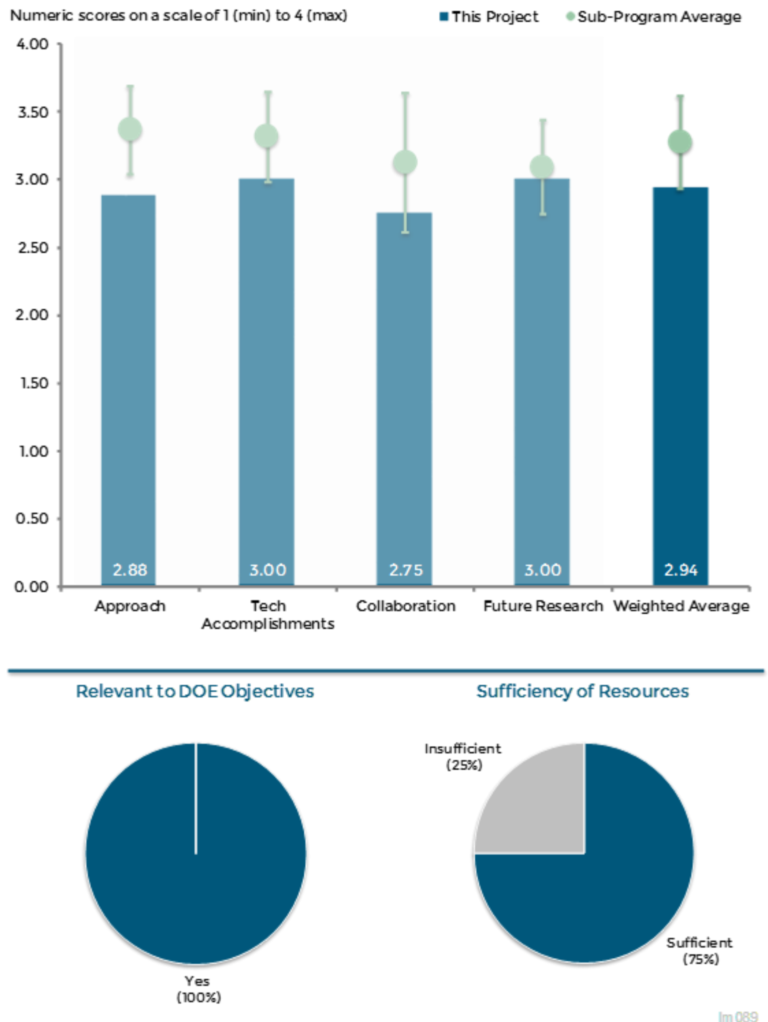

Figure 6-15 High-Strength Electroformed Nanostructured Aluminum for Lightweight Automotive Applications: Shiyun Ruan (Xtalic Corporation) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer acknowledged that the approach to the work appears very good including the application of a systematic attack on the key issues and a determined approach to the challenges that are coming up.

Reviewer 2:

The reviewer found this to be a very interesting approach and further offered that it will be interesting to see if the technique can be successfully scaled up to produce sheet on a scale needed for automotive applications.

Reviewer 3:

The reviewer acknowledged that electrolytic deposition of Al to form sheet is certainly a stretch to accomplish, and is novel, but emphasized that there are many remaining challenges that need to be overcome.

The reviewer encouraged the team and project to complete and present a detailed comparison of the project material fabrication methods to current conventional sheet fabrication methods. The reviewer offered the possibility to use as metrics the speed and cycle time for producing a one millimeter Al sheet processed from an ingot to a coil of sheet with production cycle time and process energy considerations. The reviewer further suggested the comparison of conventional to the electrolytic processes relating to technical challenges and costs. The reviewer offered a possible comparison of the properties of the project material to that of Al alloy, with zinc as the primary alloying element (7075 aluminum (Al)) which already has comparable strength and for which there is a baseline metric on-cost available for comparison to these aerospace alloys.

Reviewer 4:

The reviewer cautioned that the project appears to ignore the alloy component cost and processing costs related to energy content and line length. The reviewer further suggested that the process may prove to be feasible but may be akin to titanium in a cost arena. The reviewer judged that in the end you get 600 mega Pascals, 8% elongation for an Al alloy which has high cost due to energy use and alloy content resulting in a high carbon footprint and a material that is not recyclable due to alloy content.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer found progress on the technical issues appears to be quite strong.

Reviewer 2:

The reviewer praised very good progress considering the short time the project has been underway.

Reviewer 3:

The reviewer noted that the project is progressing towards first year go, no-go decision with the primary focus on chemistry and pointed out a need be focused on alloy cost and energy content.

Reviewer 4:

The reviewer encouraged that producing a six-foot by six-foot panel was a good start, noting it would have limited testability in a true stamping process. The reviewer therefore suggested either a roll formed or stamped aluminum-manganese (Al-Mn) door intrusion beam as a better starting target application compared to the objective target of bumper beam, offering that a sheet section of electrolytic Al-Mn alloy that is six feet wide and three feet long could potentially be roll formed or stamped door intrusion beam.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer applauded the excellent collaboration. The reviewer further suggested keeping this up, concluding that, as a startup, the collaboration is essential to going further toward getting the electrolytic sheet further processed into testable components in a functional product.

Reviewer 2:

The reviewer acknowledged the collaboration properly includes an automotive OEM and can sheet rolling Tier 1 supplier and suggested that adding a collaborator with expertise in electroplating is needed.

Reviewer 3:

The reviewer observed that it appears that the project is currently only an Xtalic nanostructured metals corporation effort, pointing out that the project has not yet progressed to a point where Fiat Chrysler Automobiles (FCA) involvement is needed and voiced the expectation that the interaction will increase in the future.

Reviewer 4:

The reviewer found that the collaboration was not described in detail making it difficult to provide a detailed assessment of the degree and effectiveness of the collaboration of the work. The reviewer found no concerns evident and further offered that the project appears to be at a relatively early stage, and concluded that a more accurate assessment should be possible in subsequent reviews. The reviewer further suggested to improve the assessment of the collaboration aspect, the project financing should be described in depth such as who is paying for what and how much is cash versus in-kind, concluding that this sort of detail is always useful in describing the degree and effectiveness of the collaboration in a large complex project.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer considered the decision gates to be good, emphasizing that they include cost targets, which are critical to commercial applications. The reviewer offered the value of $2 per pound of vehicle weight saved as an example metric used.

Reviewer 2:
The reviewer considered it a good plan and follow through to continue to compare and relate the development to current production sheet manufacturing processes.

Reviewer 3:
The reviewer observed that with the project at such an early stage it is likely much too early to assess the future directions that will, or should be taken. The reviewer further acknowledged that the team appeared to understand the challenges that the project faces and expressed confidence that the project team would be able to provide a more comprehensive view of their vision and future directions in the review of the project in the upcoming year.

Reviewer 4:
The reviewer observed that Xtalic appears to know what needs to be done to be successful in producing the Al sheet for the project, and expressed concern that the team has not fully comprehended what will be needed to scale up or to evaluate the cost of using their material in place of the incumbent material and related processes.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer concluded that the potential for weight reduction of the work appears to be substantial and is certainly aligned with the objectives of the DOE.

Reviewer 2:
The reviewer offered that increased use of high-strength Al will help reduce vehicle mass.

Reviewer 3:
The reviewer acknowledged that high strength Al is critical to achieving DOE objectives.

Reviewer 4:
The reviewer offered that further development of lightweight Al sheet is strategic and necessary to meet the DOE VTO objectives in transportation light–weighting.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer concluded the funding is insufficient suggested that there was an additional need for budget for a cost modeler to develop cost model of electro-formed sheet processing in order to set alloy cost targets. The reviewer warned that the cost target of $2 per pound of vehicle weight saved does not provide much room for alloy costs and processing costs.

Reviewer 2:
The reviewer commented that this project looks to be appropriately funded.

Reviewer 3:

The reviewer observed that the project is at a relatively early stage and little information on the project financing was offered, concluding it was difficult to provide an assessment of the adequacy of the resources available. The reviewer offered that because the presenter did not identify any funding issues it was concluded that the resources were adequate.

Technical Cost Modeling for Vehicle Lightweighting: Tony Mascarin (IBIS Associates) - lm090

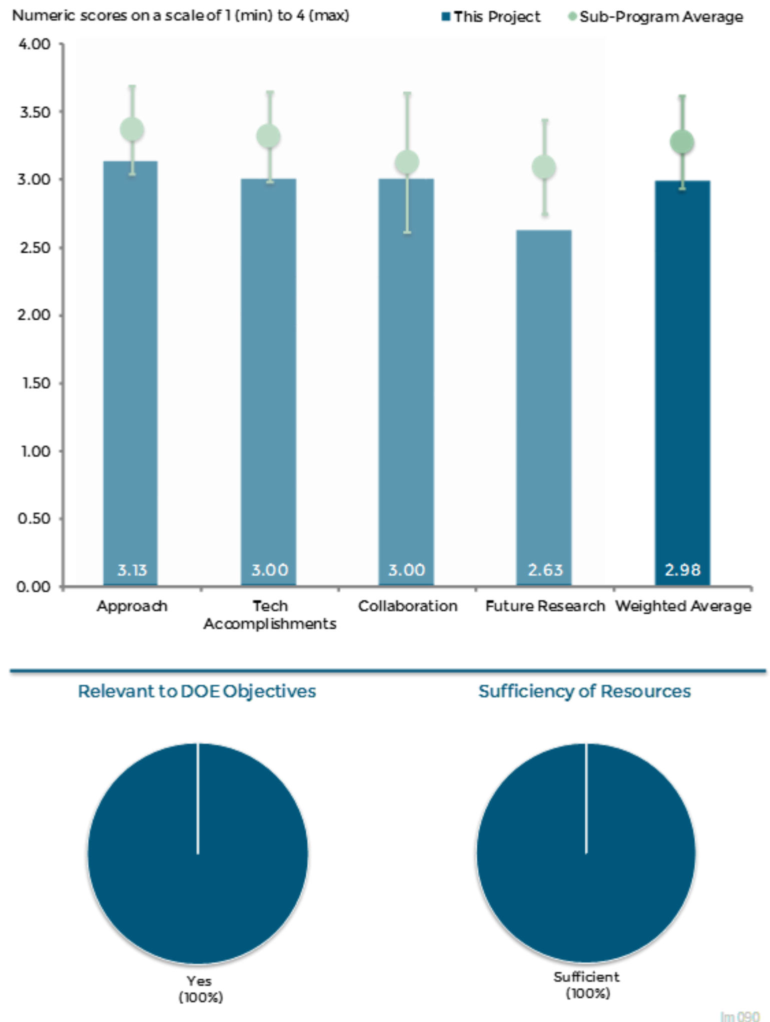

Figure 6-16 Technical Cost Modeling for Vehicle Lightweighting: Tony Mascarin (IBIS Associates) – Lightweight Materials

Presenter

Tony Mascarin, IBIS Associates.

Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the approach is very sound and it has considered the many studies conducted so far.

Reviewer 2:

The reviewer found the approach of technical cost modeling appropriate for the investigation, and cautioned that there is little confidence in the projected costs of materials and manufacturing processes which are not yet in high volume production.

Reviewer 3:

The reviewer found the approach stated in the presentation is reasonable, but judged that there were not sufficient details provided on the assumptions required for costing. The reviewer further found the elements in consideration reflecting on costs were not well described. The reviewer suggested that because much of the study includes the critical review of prior body of work conducted by other organizations, it would be prudent for IBIS to describe how the information was organized for critical review and assess the numbers accordingly as though the team was responsible for standing behind the generated cost values. The reviewer suggested that sanitized material cost, conversion cost, assembly cost, and labor cost could have been provided from the other programs. The reviewer further suggested that because this was the first review at the DOE, it would have been important to spend a bit more time describing the key outputs that were generated in the study.

Reviewer 4:

The reviewer found that modeling of the technical cost considering a value of dollars per pound of vehicle weight saved was too obscure of a target for a car vendor to simply explain to the customer.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer praised the team for completing the project as promised with the cost details based on the available information. The reviewer pointed to the results indicating customer expectations for power, acceleration, customer features, and luxury would need to change to achieve even a 30% weight reduction as a significant finding.

Reviewer 2:

The reviewer found it was very difficult to comment on technical accomplishments and was not clearly understanding the approach and what the relevance of final numbers presented. The reviewer said carbon fiber costing could have been explained better offering that the number of vehicles produced for BMW i3 and costing associated with that vehicle is much different than the costing of similar size vehicle at higher production volumes. The reviewer further pointed out that the integration of carbon fiber parts into an existing plant that utilizes steel and Al joining and the related cost impacts were not described.

Reviewer 3:

The reviewer calculated that the analysis had indicated the cost of reducing the first 30% of mass from the average 3,300 lbs. vehicle is approximately $3,500, resulting in a cost average of $3.50 per pound of vehicle mass reduction. The reviewer pointed out that further reduction beyond 30% at a cost of $3.42 per pound is not a feasible selection. The additional cost estimate needs to be higher than $3.50 pound.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that collaboration with others appeared reasonable and suggested it would have been nice to understand the details behind the collaboration data that were provided to IBIS, such as comparison of existing plants to new plants and the assumptions used for material cost, conversion costs and other parameters.

Reviewer 2:

The reviewer commented that the team claims to have collaborated with OEM vehicle design engineers and the Multi Material Lightweight Vehicle (MMLV) project team to understand costs reductions in customer features and future scenarios.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the project work is done on time and recommended no future work should be required here. The reviewer further stated that future cost models on carbon fiber are not appropriate for DOE funding because the drive for fuel economy improvements will drive the commercial cases.

Reviewer 2:

The reviewer simply noted the end of the project.

Reviewer 3:

The reviewer suggested that it would have been good if IBIS stated the assumptions that they were using for the identified research areas in particular technical process cost modeling and how those assumptions derived the future research areas.

Reviewer 4:

The reviewer mentioned that the project tries to yield estimates on additional costs of lightweighting yet only provides one sentence relating to the gas saving of 7% fuel saving for a 10% weight reduction. The reviewer pointed out that this last number also depends on the efficiency of the engine, the transmission, the road conditions and other factors not considered and suggested a new approach to that larger difficult problem should be establish, with the help of the car makers, the approach carmakers would like to use to present such material to their customers.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer applauded as a significant finding that the customer expectations for cars would need to change to achieve even a 30% weight reduction.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

Phase Transformation Kinetics and Alloy Microsegregation in High-Pressure Die Cast Magnesium Alloys: John Allison (University of Michigan) - lm091

Presenter

John Allison, University of Michigan.

Reviewer Sample Size

A total of four reviewers evaluated this project.

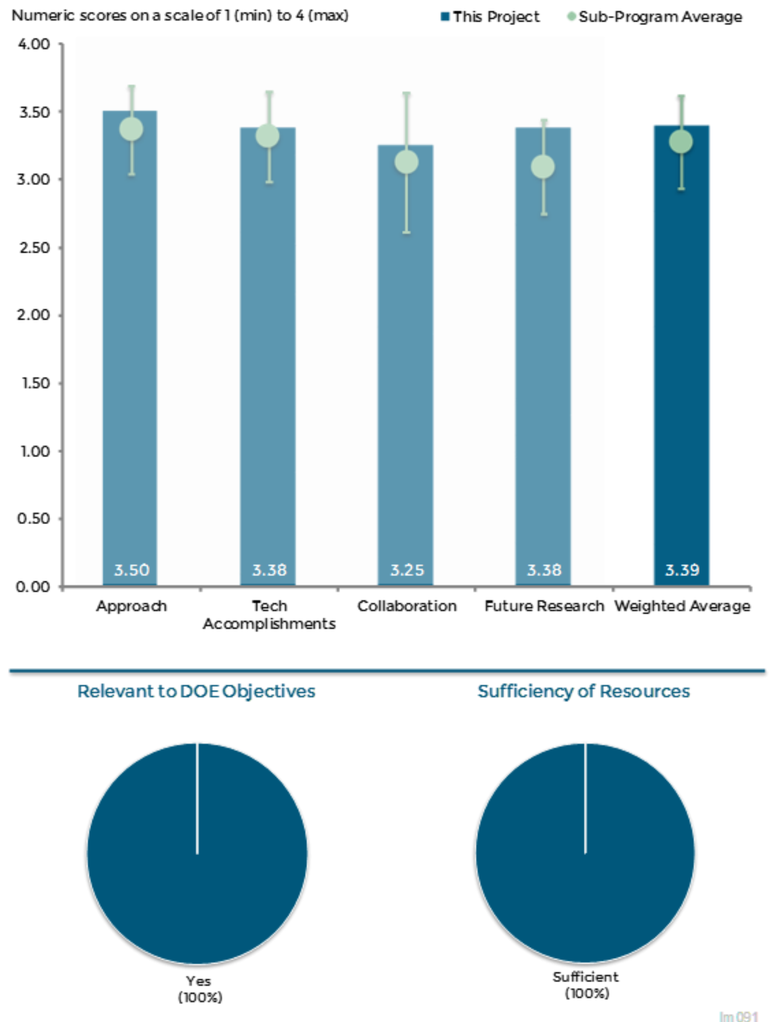

Figure 6-17 Phase Transformation Kinetics and Alloy Microsegregation in High-Pressure Die Cast Magnesium Alloys: John Allison (University of Michigan) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the project presented careful and detailed macro-segregation analysis in high pressure die casting (HPDC) Mg alloys, and commented that the data being generated in this project will be required for future ICME projects on HPDC Mg.

Reviewer 2:

The reviewer commented that it was a clearly articulated approach with well-defined tasks.

Reviewer 3:

The reviewer commented that the analysis of multiple alloys with different elements is well planned.

Reviewer 4:

The reviewer questioned the uncertainties of the chemical concentration measurements in the microstructure, and whether is it a function of how close you are to the edge of the phase.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer commented that the project team seems to be on a good track, with experiments complimenting the modeling.

Reviewer 2:

The reviewer commented that the team completed extensive work in experimentation and modelling.

Reviewer 3:

The reviewer questioned if any inferences can be drawn from of all of the data acquired so far to in-service mechanical performance of HPDC and how heat transfer coefficients were measured. The reviewer pointed to Slide 17, and suggested an improvement to provide some indication as to how the various parameters are acquired. The reviewer further offered the example that these parameters were possibly acquired from other programs, or computed via an ICME approach, and suggested the team present how all of the results tie together to suggest improvements to HPDC Mg alloys.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer praised that there appears to be excellent engagement and involvement of researchers at Ford, the University of Michigan, Ohio State University and Tsinghua Universities.

Reviewer 2:

The reviewer commented that the partners are Ford Motor Company, Ohio State University and Tsinghua University.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that things look good as the project team is getting samples and the analytical capabilities seem to be working.

Reviewer 2:

The reviewer commented that the plan for future work has been clearly laid out.

Reviewer 3:

The reviewer commented that micro segregation as well as macro segregation are significant in die cast due to extreme rapid cooling rates and high velocity and suggested that efforts should be made to identify the effects of these process parameters.

Reviewer 4:

The reviewer cautioned that the development of micro-models for microstructure prediction may be unrealistic and it seems to be a very tall order for this project. The reviewer questioned whether microstructure prediction should be attempted only with a thermodynamic approach.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that HPDC is going to be a needed technique for these materials to be used commercially, and suggested this effort needs to be conducted in parallel with development of better performance alloys.

Reviewer 2:

The reviewer commented that improved ability to predict characteristics of HPDC Mg will improve the ability to optimize the design and reduce the mass of cast components, the predominant form of Mg currently used in automobiles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

In-Situ Investigation of Microstructural Evolution During Solidification and Heat Treatment in a Die-Cast Magnesium Alloy: Aashish Rohatgi (Pacific Northwest National Laboratory) - lm092

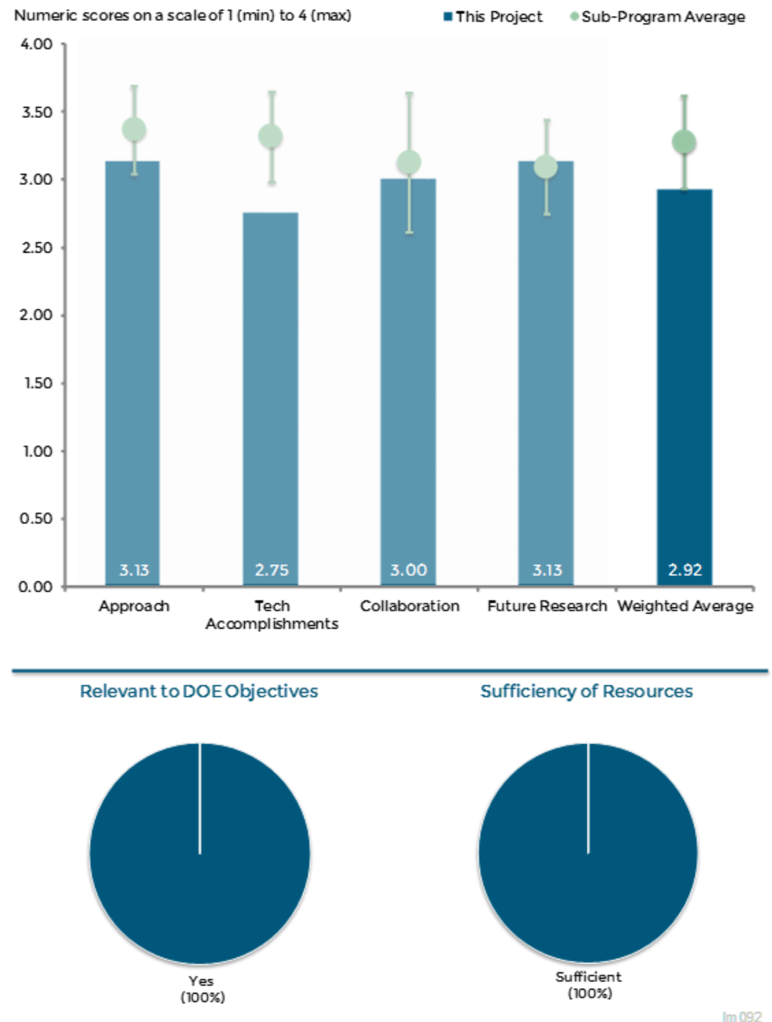

Figure 6-18 In-Situ Investigation of Microstructural Evolution During Solidification and Heat Treatment in a Die-Cast Magnesium Alloy: Aashish Rohatgi (Pacific Northwest National Laboratory) – Lightweight Materials

Presenter

Aashish Rohatgi, Pacific Northwest National Laboratory.

Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that it was a very good integrated approach comprehending modeling and experimental results in studying solidification and heat treatment.

Reviewer 2:

The reviewer applauded the novel approach to measuring diffraction data for Mg and Mg-Al alloy ($Mg_{17}Al_{12}$) in an electron microscope.

Reviewer 3:

The reviewer acknowledged the use of transmission electron microscopy (TEM) for the in-situ solidification experiments is an excellent idea and cautioned that measuring the temperature will be a challenge.

Reviewer 4:

The reviewer criticized that the inability to measure the temperature of the sample during the experiment, or at the temporal scale, to look at the cooling and solidification kinetics, is a major problem and will potentially negate any experimental observations coming out of this project. The reviewer further commented that thin film and free surface artifacts inherent in TEM experiments and the effect of the silicon nitride substrate on crystallization are not terribly well addressed.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer commented good progress.

Reviewer 2:

The reviewer cautioned, that unless the project team can work out the kinks, this project might be in trouble.

Reviewer 3:

The reviewer questioned where the material parameters in the model on Slide 13 originated from, and commented that on Slide 16, it appears that two potentials were examined, both of which were found to be deficient, with the first giving negative components of the elasticity tensor and the other requiring modifications by the Principal Investigator (PI) to get close to density functional theory (DFT) values. The reviewer further questioned the point of the potentials and suggested that if one were to change the alloy content in the Mg alloy, then the potential approach would again be problematic and one would have to again appeal to DFT. The reviewer suggested to discuss these issues with National Institute of Standards and Technology (NIST). The reviewer requested on Slide 17 to include temperatures at which the reported data was acquired with special focus on experimental data. The reviewer further questioned whether the project is comparing zero Kelvin DFT results with room temperature experimental results and commented that the same question applies for data on Slide 18. The reviewer was concerned how to relate the data on Slides 17 and 18 to support the main objective of this project, which is to measure in situ kinetic information of Mg die castings. The reviewer further stated that that these topics are completely unrelated with substantive details on the various models. The reviewer questioned whether elastic properties support understanding of microstructural evolution in non-equilibrium Mg die cast microstructures, and has the same question for the effects of defects and vacancies. Finally, the reviewer inquired about how the kinetic Monte Carlo method for simulating microstructural evolution of heat-treated sputtered films ties in.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that collaborations were limited to one, and their results are preliminary.

Reviewer 2:

The reviewer commented that ESI appears to be actively engaged in execution of the project and incorporation of its findings in ProCAST casting simulation suite.

Reviewer 3:

The reviewer questioned what ESI is contributing to this project, such as the ProCAST simulations for example.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the plan is good and hoped the team can get the scope working and figure out how to measure the temperature of the sample spatially and temporally.

Reviewer 2:

The reviewer commented that in Slide 12, problems with focused ion beam (FIB) are identified and questioned whether the current approach involves using sputtered Mg-Al and Mg-Al-Zn films for heat treatment work.

The reviewer further questioned what the approach is to determine diffusion coefficients and effective migration barriers as a function of Al concentration and temperature. The reviewer said Slide 21 stated that the technical barrier identified pertains to inability to measure temperature inside the DTEM, then Slide 22 says perform DTEM experiments. The reviewer questioned how the barrier is to be overcome.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that solidification processing of Mg is the first way this class of alloys will be incorporated into lightweight vehicles, and the kinetics and microstructural studies during rapid solidification are relevant and needed.

Reviewer 2:

The reviewer commented that Mg is a potential lightweight replacement material for heavier ferrous and non-ferrous alloys in automotive structures.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

High-Throughput Study of Diffusion and Phase Transformation Kinetics of Magnesium-Based Systems For Automotive Cast Magnesium Alloys: Alan Lou (Ohio State University) - lm093

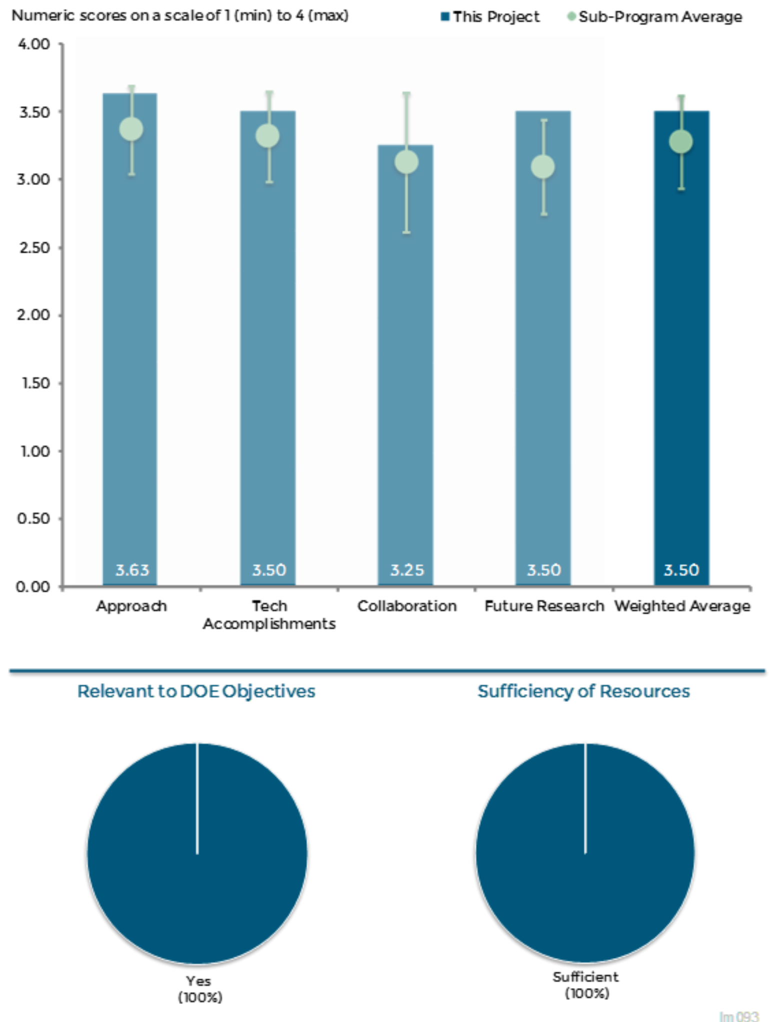

Figure 6-19 High-Throughput Study of Diffusion and Phase Transformation Kinetics of Magnesium-Based Systems For Automotive Cast Magnesium Alloys: Alan Lou (Ohio State University) – Lightweight Materials

Presenter

Alan Lou, Ohio State University.

Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded the great experimental approach for generating much needed liquid diffusion data, adding that this is a tough problem and the experiments appear to be novel and sound.

Reviewer 2:

The reviewer commended that a diverse and detailed approach was established.

Reviewer 3:

The reviewer acknowledged the nice experimental technique produces a lot of data with every run and pointed out that the effect of hydrostatic pressure when the central metal melts while rigidly encapsulated by the alloying solid metals was not really discussed or explained adequately during the question and answer session. The reviewer suggested that the project team needs to address this explicitly and see if there is an effect on the data.

Reviewer 4:

The reviewer offered that the solution and precipitation of particles is controlled by diffusion and the mechanism is not well understood for Mg alloys and further relayed that this is one of the works focused on this subject funded by DOE. The reviewer commented that the effort to measure both liquid phase and solid phase diffusion of different elements is very well thought out.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:
The reviewer commented that this program will generate a ton of diffusion data for the modelers to use.

Reviewer 2:
The reviewer commented very good progress in experimentation, simulation and validation.

Reviewer 3:
The reviewer commented that in the liquid phase diffusion experiments, for Al-Mn the evaluation is carried out at 600°C, where none of the elements are liquid. More explanation is needed.

Reviewer 4:
This reviewer explained that comments applied to the uploaded version of this presentation because another version was actually presented at the 2015 DOE AMR by the PI, with Dr. Luo's name being the only name on the cover slide. Referencing Slide 20, this reviewer asked which part of the diffusion coefficient versus 1/T curves pertain to liquid and which pertain to solid. If solid is included in the diffusion coefficient versus 1/T data, the reviewer inquired why are there not two curves to account for diffusional anisotropy of impurities in HPC Mg (via vacancy diffusion, for example). It appeared that the data in Slide 20 was computed from the literature and does not show results from the measurements conducted in this project. In Slide 22, which details the precipitation model, the reviewer said that it would be helpful to have a bit more detail as to which of the model parameters (e.g. material properties) can be measured, and which result from fitting to experimental data. The reviewer also referenced Slide 23 and inquired about how good the data was fitting and requested that this be quantified.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented it looks like things are working well

Reviewer 2:
The reviewer offered that this is a basic science project and it is understandable that the partners are more on the academic side than industry.

Reviewer 3:
The reviewer cautioned that it appears that Ohio State University is doing the work and simply conveying information to other partners rather than actively engaging those partners.

Reviewer 4:
The reviewer questioned what GM is providing to the project other than alloy suggestions, and offered that it is likely that GM could support the project with die casting facilities and measurement capabilities. The reviewer requests to see a more definitive role for GM in this project. The reviewer relayed that Computherm is the other collaborator.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer acknowledged that a well identified multi-prong approach has been laid out.

Reviewer 2:

The reviewer offered high expectations for future work.

Reviewer 3:

The reviewer commented on the team's presentation of the Sheil model and the fact that phase transformation kinetics in Mg alloys are not well understood, expressing concern that the future effort to resolve was not provided in sufficient detail and requests more detail on how the project will specifically address this issue.

Reviewer 4:

The reviewer commented that it may be useful to see what will be the diffusion in alloys as this can be studied in future.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the benefit is in long-term, the understanding of diffusion mechanism, may lead to development heat treatable Mg alloys that can be used in place other high-strength materials such as steel.

Reviewer 2:

The reviewer commented that diffusion data for the alloying elements of Mg is vital to the accurate modeling of microstructural development during hot processing of these lightweight alloys.

Reviewer 3:

The reviewer commented that this project focuses on lightweight Mg cast alloys.

Reviewer 4:

The reviewer commented that this is an enabler for increasing the use of Mg by improving modelling capability and accuracy.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

Microstructure and the Corrosion/Protection of Cast Magnesium Alloys: Karl Sieradzki (Arizona State University) - lm094

Presenter

Karl Sieradzki, Arizona State University.

Reviewer Sample Size

A total of three reviewers evaluated this project.

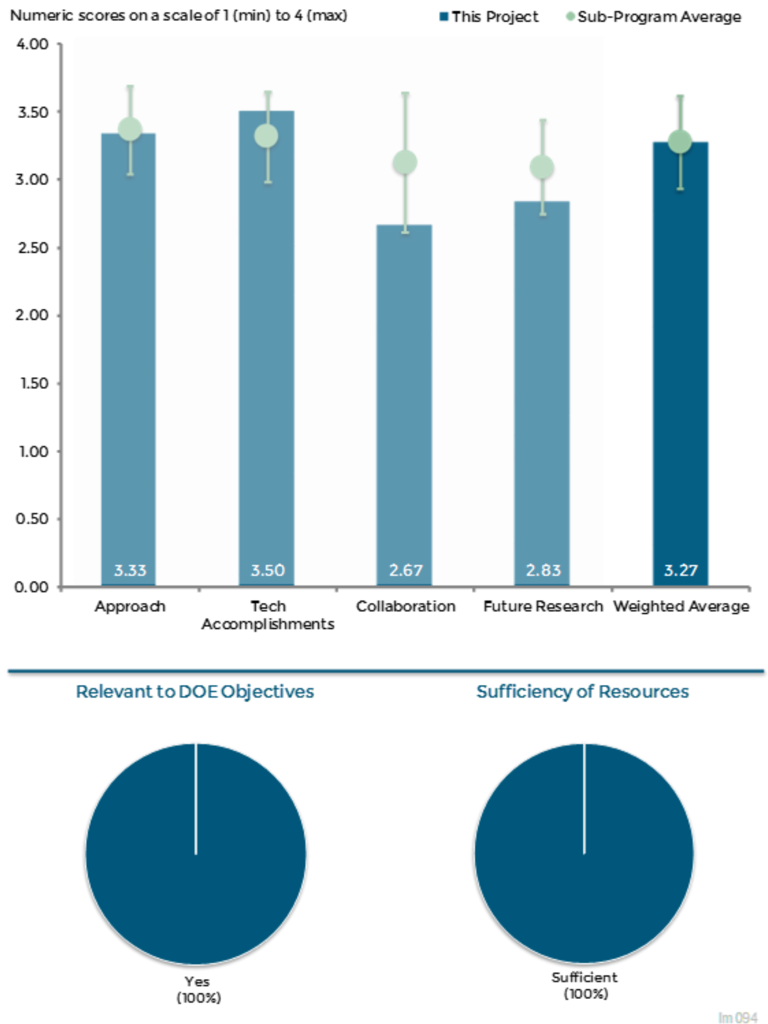

Figure 6-20 Microstructure and the Corrosion/Protection of Cast Magnesium Alloys: Karl Sieradzki (Arizona State University) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer surmised that this project is aimed at studying the corrosion of cast Mg alloys and it appears to be a very well organized and properly conducted piece of work.

Reviewer 2:

The reviewer reported the approach was not clear and suggested that the presenter more clearly explain how the various tasks will fit together to generate the predication model, develop the basic understanding of oxidation and corrosion, and how this leads to the development of corrosion protection schemes.

Reviewer 3:

The reviewer commented that it is difficult but necessary effort and very good scientific work. The reviewer suggested to adapt the communication more to people not in the line of work of the authors.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer applauded the progress is outstanding, pointing to the new measurement protocol that appears very effective. The reviewer related that a lot of data was available and that the slides were not as clear as the presenter. The reviewer offered, for example, that one slide mentioned that EDS probe measures both electrically connected and disconnect Al, which sounds good, but the presenter said that one cannot distinguish between these two effects, which sounds bad. The reviewer found the slides too technical and detailed on the data and did not provide enough on the conclusion and implications of the data.

Reviewer 2:

The reviewer offered that given the type of study that the work presented represents, the work appears to be of fine quality with a highly repeated and confirmatory set of results and a well-organized program.

Reviewer 3:

The reviewer commented that overall the system too complicated and is concerned that the presented hypotheses may not capture the real effect and offered that maybe this will come in a follow-on project.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented it appeared that the collaboration is going well with the work of each partner acknowledged on the various slides that were presented.

Reviewer 2:

The reviewer acknowledged this is a very good collaboration to cover a lot more cases and suggested there is a need to add Arizona State University's and the University of Toronto's roles and work to the collaboration slide. The reviewer applauded the advisory aspect of University of Toronto and would like to know more on why they are involved and what their contribution is.

Reviewer 3:

The reviewer affirmed this may be a good academic collaboration but the fact that the industry is absent is a real problem. The reviewer suggests that such a work is necessary and, as presented, should be moved to the DOE Office of Basic Science.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the future work slide is excellent and will hopefully be better when the approach slides are improved.

Reviewer 2:

The reviewer commented that the outline of future work is better than satisfactory but that without an industry presence there is concern about the future of the project.

Reviewer 3:

The reviewer commented that not very much was said about the future work but it does appear that a set of future steps is under development. The reviewer suggested that the presentation at the next review focus less on an extensive review of highly detailed scientific results and more on the project performance and future plans, perceived barriers and an overview only of key accomplishments, which are of primary importance to DOE's vehicle weight reduction goals.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that Mg is likely a core part of future vehicle technology and this work does support DOE's objective.

Reviewer 2:

The reviewer commented that corrosion is a large barrier to Mg adoption and funding to overcome this barrier is appropriate.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that funding appears sufficient to achieve goals.

Reviewer 2:
The reviewer commented that nothing on the budget was presented except the global financing of the entire project and so it is difficult to fully assess the adequacy of the resources available.

A System Multiscale Modeling and Experimental Approach to Protect Grain Boundaries in Magnesium Alloys from Corrosion: Mark Horstemeyer (Mississippi State University) - lm095

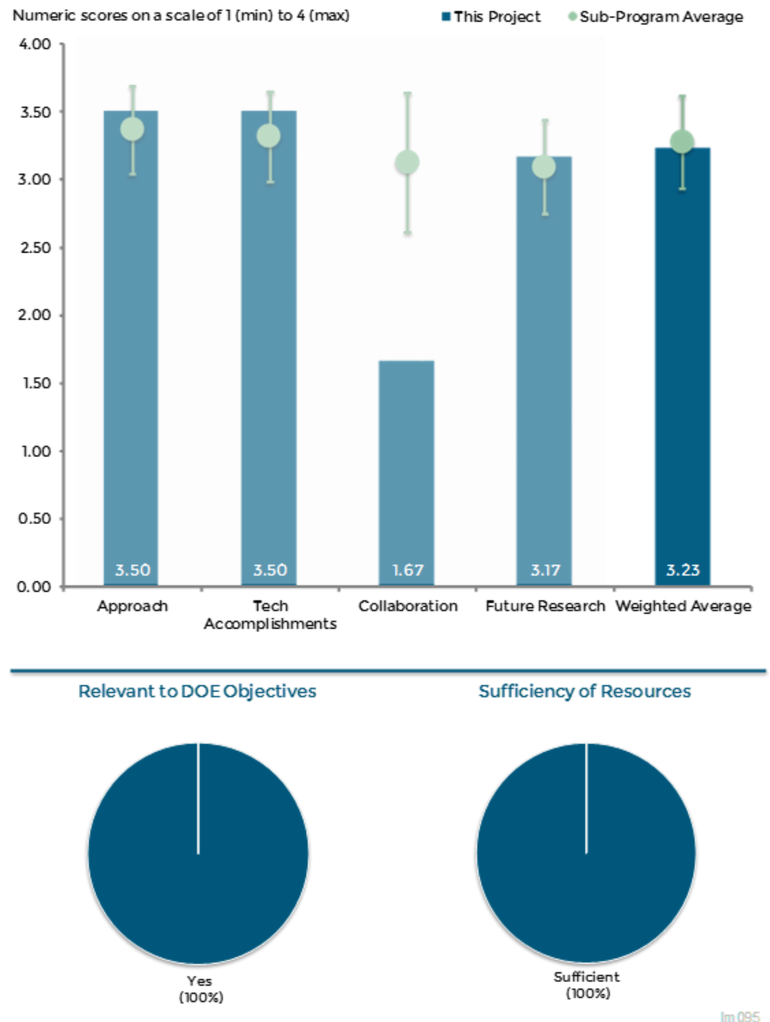

Figure 6-21 A System Multiscale Modeling and Experimental Approach to Protect Grain Boundaries in Magnesium Alloys from Corrosion: Mark Horstemeyer (Mississippi State University) – Lightweight Materials

Presenter

Mark Horstemeyer, Mississippi State University.

Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented the overall approach seems to be highly integrated and well planned among a group of experienced and talented researchers working with the proper equipment.

Reviewer 2:

The reviewer commented that the approach is clearly outlined and very well-articulated and applauded the high degree of interdependence between the various models. The reviewer recommended adding a risk analysis and risk mitigation plan considering the case that one or more of the models proved not to behave as expected resulting in poor validation or the case where the data is more difficult to collect resulting in a large variation in results. Additionally, the reviewer recommended confirming metrics of model quality and risk considering the probability of occurrence and impact.

Reviewer 3:

The reviewer commented that it is difficult but necessary effort and very good scientific work. The reviewer suggested adapting the communication more to people not in the line of work of the authors.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer commented that technical accomplishments were very systematic and showed outstanding progress.

Reviewer 2:

The reviewer commented that the work appears to have been quite successful.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that collaboration between Mississippi State and University of Illinois at Urbana-Champagne appears to be highly integrated and thus quite successful. The reviewer offered that industry participation should be considered as it can be of great help in ensuring that projects are going in a useful direction and that the results are likely to be adopted in the marketplace, further commenting that industry involvement is really the only way for the results to have any real impact on vehicle weight, which is the whole idea of the DOE program.

Reviewer 2:

The reviewer commented that no information was found on collaboration and that this slide is missing from the presentation so there is no idea who is doing what.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer pointed out that this project is nearly complete and the team said relatively little about future plans.

Reviewer 2:

The reviewer indicated that the future work is clear, because the approach was so well articulated and would like more information on the model validation such as what alloys will be validated, how are they determined, and what are the metrics and values to be used to demonstrate success.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that future vehicles must be lighter to save fuel and a core component of the weight reduction effort is the introduction of lower density materials such as Mg.

The reviewer further pointed out that the present project is aimed at making the widespread use of Mg in mass-market automobiles much more feasible and therefore does support the DOE objectives to reduce vehicle weight.

Reviewer 2:

The reviewer commented corrosion is a large barrier to Mg adoption, and funding to overcome this barrier is appropriate.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that little was said about the financing of the project so it is difficult to assess the adequacy of the funds on the conduct of the work.

Reviewer 2:

The reviewer commented that funding appears sufficient to achieve goals.

Corrosivity and Passivity of Metastable Magnesium Alloys: Guang-Ling Song (Oak Ridge National Laboratory) - lm096

Presenter

Guang-Ling Song, Oak Ridge National Laboratory.

Reviewer Sample Size

A total of three reviewers evaluated this project.

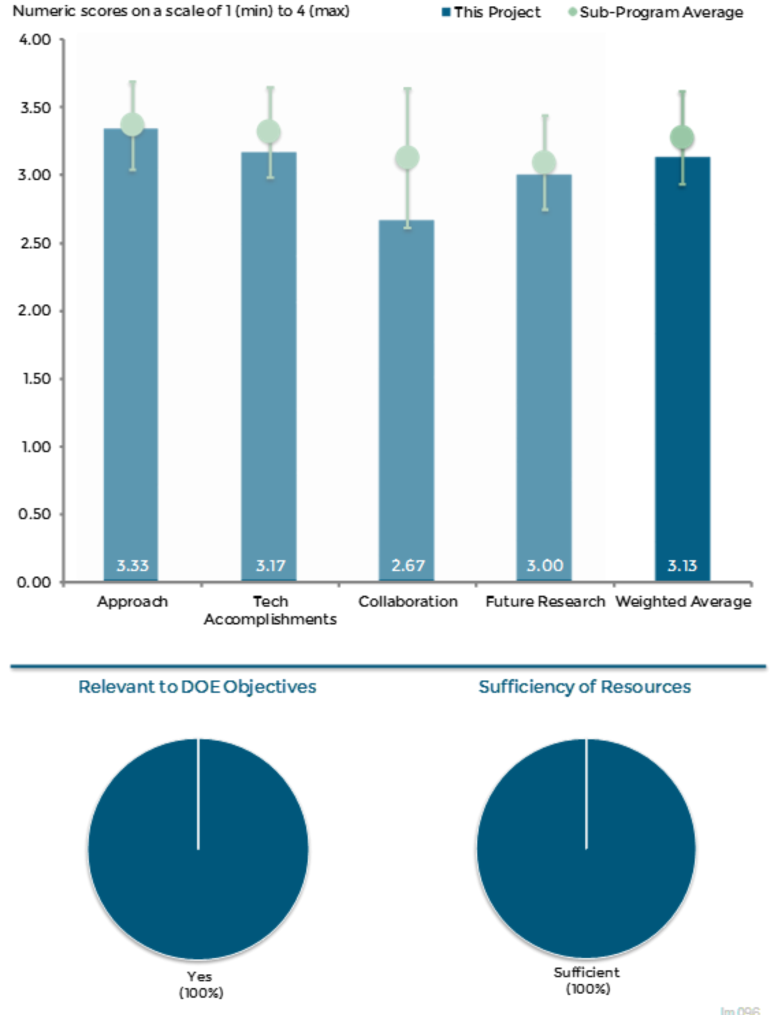

Figure 6-22 Corrosivity and Passivity of Metastable Magnesium Alloys: Guang-Ling Song (Oak Ridge National Laboratory) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer reported that the approach seems to be systematic and the result of good planning by knowledgeable team members; however, the presentation concentrated largely on technical results and relatively little was said about how the project is actually being conducted, so it difficult to comment on the overall effectiveness of the approach.

Reviewer 2:

The reviewer applauded the commendable approach to make stainless Mg to improve corrosion resistance, and requested clarification on whether the stainless Mg is created by using a doping element with limited solubility or by creating a new phase.

Reviewer 3:

The reviewer reported that the approach is clearly outlined and very straightforward, but not as interesting as the basic idea offering that it is primarily an empirical data collection study. The reviewer further acknowledged that the using a sputtering method of creating alloys is a good idea.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer related that it appears that a good deal of technical data has been obtained and several key pieces of new knowledge have resulted from the work; however, a comparison of expected milestones and results achieved was never presented and so it is challenging to state for sure just how well the project worked.

Reviewer 2:
The reviewer praised the activity citing excellent work and accomplishments in the first year.

Reviewer 3:
The reviewer relayed that the comparison between Mg-titanium (Ti) and Mg-chromium (Cr) show promise to be very interesting and either one might resolve the Mg corrosion issue.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that the collaboration is explained and is clear for this project.

Reviewer 2:
The reviewer commented that the team appears to be good and seems to work well together; however, the reviewer also expressed to be un-convinced that the industry consultant had any input in the presented material and offered that a real industry presence is a necessity on a project to result in some real applications.

Reviewer 3:
The reviewer commented that the members of the research team were flashed up on the screen but nothing further was said about how the various entities are involved in the work the budget split-up, or the tasking assignments. The reviewer acknowledged, in fact, that good results have been obtained, suggesting that the collaboration is actually working, but could not be sure.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer commented that the project is nearly completed and so the prospects for future work really refer to future, separately funded projects. The reviewer suggested to add some words about the potential for a cost-effective automotive solution as little or nothing was said about estimates of future costs.

Reviewer 2:
The reviewer observed that the future work is clear, because the approach is so straightforward.

Reviewer 3:
The reviewer found the prospects for future work are too skimpy and not detailed enough.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer explained that the work is related to reducing the corrosion of Mg alloys in automotive service and therefore is clearly is aligned with the DOE objective to reduce vehicle weight.

Reviewer 2:
The reviewer concluded that corrosion is a large barrier to Mg adoption and finds funding to overcome this barrier is appropriate, even if not all approaches will be successful. The reviewer further declared that if the problem was easy, it would have been solved by now.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer suggested it would be an improvement to see more industry involvement and more funding for the idea of stainless Mg.

Reviewer 2:

The reviewer mentioned that little was said about the budget and no issues about its adequacy were raised during the presentation.

Reviewer 3:

The reviewer commented that the funding appears sufficient to achieve goals.

Laser-Assisted Joining Process of Aluminum and Carbon Fiber Components: Adrian Sabau (Oak Ridge National Laboratory) - lm097

Presenter

Adrian Sabau, Oak Ridge National Laboratory.

Reviewer Sample Size

A total of four reviewers evaluated this project.

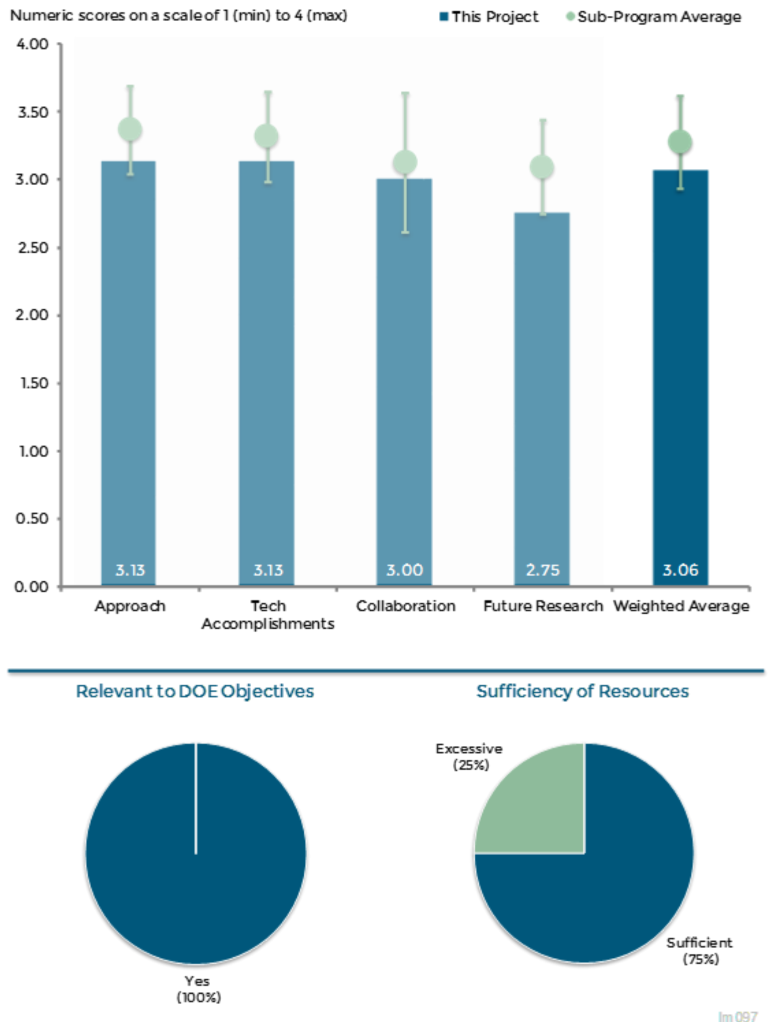

Figure 6-23 Laser-Assisted Joining Process of Aluminum and Carbon Fiber Components: Adrian Sabau (Oak Ridge National Laboratory) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer related that this was a novel approach to joining involving laser-assisted roughening of material surfaces.

Reviewer 2:

The reviewer commented that the approach chosen is generally good, establishing baseline information set for the raster and spot methods of surface roughening. The reviewer further stated, however, the approach could be improved with go versus no-go decision points. The approach should also comprehend typical joint configurations such as peel tests.

Reviewer 3:

The reviewer praised the idea is novel and interesting while offering that the presentation suffers from clarity. The reviewer further stated that the question and answer session required too many questions for the reviewers to clearly understand what was done. The reviewer believed the need for a slide that explains the difference between raster and spot. Raster is mentioned for the first time on Slide 14. The reviewer questioned whether Slide 7 is intended to conveys the process on Al, expressing the understanding that the process is only on the composite side. The reviewer further suggested the need to explicitly state that the process is applied to both materials. The reviewer suggested the results be presented with statistical significance levels, assuming that at least two replicates were conducted for each trial and also provide military relevance because TARDEC is a co-sponsor.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer commented that there appears to have been a lot of work conducted, even more than was fully presented. The reviewer stated that some of the results appear to have been withheld because of propriety as well as patent potential, which is understandable; however, the reviewer found it difficult to assess the amount of work conducted without more disclosure.

Reviewer 2:

The reviewer commented that if the project involves joining of Al alloys in the family (Al 5XX) to carbon fiber, it seems that the team may need to be concerned about corrosion, especially for metal alloys containing Mg.

Reviewer 3:

The reviewer judged that this appears to be a needlessly high technology solution to a problem that can be addressed using conventional methods, considering it only provides marginally better performance than with conventional techniques.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer related that the collaborators are Magna, Plasan, and 3M.

Reviewer 2:

The reviewer cautioned that collaboration was limited to Magna providing material and 3M adhesive advice, and suggested that the project would improve from more collaboration with the U.S. Army and possibly automotive OEM advisors.

Reviewer 3:

The reviewer expressed that it is not obvious that collaborators have done anything more than providing materials, or providing purchased services.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that future work can be improved to look at the most reasonable/efficient combination of surface preparation. The reviewer suggested a more structured approach with clear metrics, such as processing time and cost; and joint strength. The reviewer related that there appears to be seven possible combinations including the baseline, given three preparation conditions for Al and two for carbon fiber component CFC plus baseline.

Reviewer 2:

The reviewer related that it seems that the proposed surface roughening process is an extra step in joint manufacturing and questioned the feasibility from a cost standpoint. The reviewer also questioned if there is any modeling planned that would lead to an optimal design of the patterned joint interfaces via laser roughening, questioning how the geometry of the surface topography influence surface wetting of the adhesive.

Reviewer 3:

The reviewer cautioned that while corrosion is an issue for dissimilar material joints, it is not apparent that this technique would do anything but aggravate the corrosion, and suggested that because there is little apparent benefit to the use of this technique, only limited improvement in shear strength, the additional expense to document corrosion behavior appears to be a needless expense. On this basis the reviewer suggests to simply wrap up the project.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that dissimilar material joining is considered one of the most important technical barriers to the multi-material lightweight vehicle.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that funding appears sufficient to achieve goals.

Reviewer 2:

The reviewer commented that there is no apparent need to continue the work.

Brazing Dissimilar Metals with a Novel Composite Foil: Tim Weihs (Johns Hopkins University) - lm098

Presenter

Tim Weihs, Johns Hopkins University.

Reviewer Sample Size

A total of three reviewers evaluated this project.

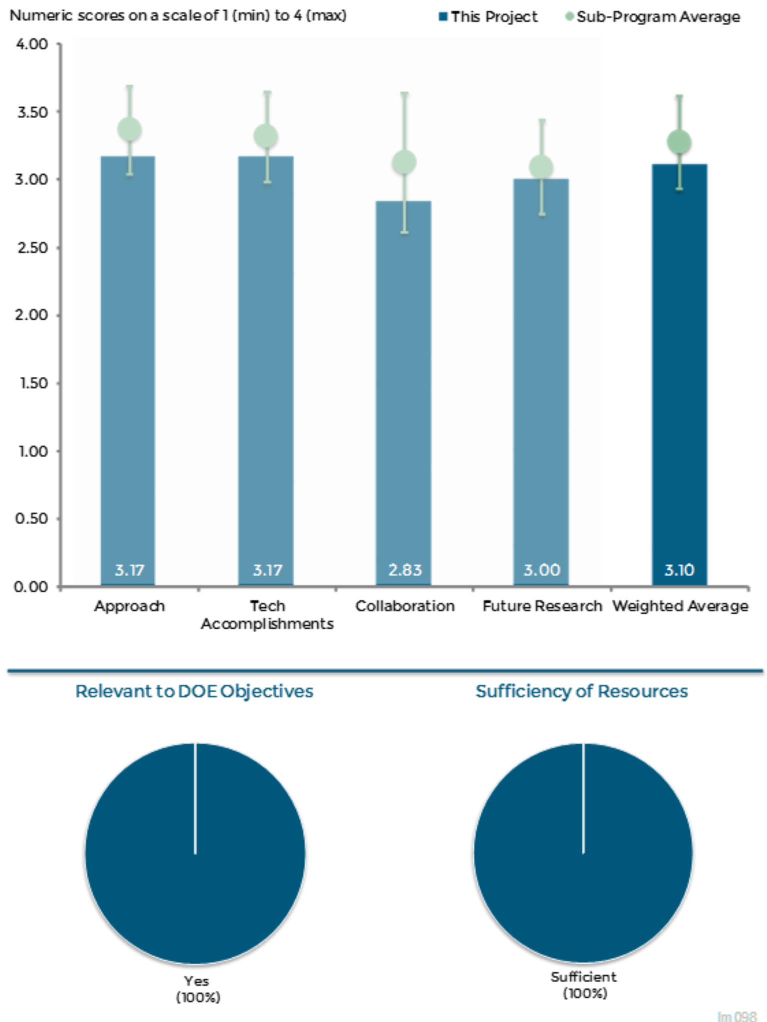

Figure 6-24 Brazing Dissimilar Metals with a Novel Composite Foil: Tim Weihs (Johns Hopkins University) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commended the approach as novel and acknowledged that the project is well structured and presented. The reviewer suggested that given the initial results a risk mitigation plan may be warranted for the case of failing the go, no-go criteria of 10 mega-Pascal. The reviewer also suggested a slide that shows a structured research approach, such as a series of designed experiments for identifying the particular chemistries and process parameters. The reviewer related that while the presentation was very well presented, it also is apparent that the problem is quite complex and that there is likely an optimum combination of chemicals, their quantity, reactant spacing, and foil thickness for a particular set of materials to be joined. The reviewer suggested that a fishbone or other diagram identifying the variables and their levels and how the tasks are addressing determining their optimal level would be helpful.

Reviewer 2:

The reviewer praised that the team was doing well at addressing the fundamentals of joining with the reduction-oxidation (redox) foils and suggested that the team keep in mind right from the start a vision of how and where this foil, if successful, will be used in automotive production as this could help identify suppliers or other collaborators to engage.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer commented that significant progress was made relating that lot of experiments were conducted, and a lot of information gathered and lessons learned. The reviewer judged that accomplishments were well explained and presented.

Reviewer 2:
The reviewer commented that this activity is obviously still very much a work in progress. The reviewer found it encouraging to see that moderate bond strengths can be obtained even now; however, related that it was redundant for the team to state that the bond strength depends strongly on foil chemistry and the materials being bonded because that is the thrust of this project. The reviewer encouraged the work, stating it will be interesting to see what comes from the dilution studies and optimization.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that collaborations are limited at this time and suggested it may be worthwhile to reach out to other interested parties that work in the automotive research area and attend the Annual Merit Reviewer regularly as one of the OEM reviewers had a comment that the presenter acknowledged was helpful.

Reviewer 2:
The reviewer stated that it is unclear what Dr. Woll's role is in the project, and therefore collaboration, interaction and coordination are not readily apparent.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer suggested that a slide on the mathematical modeling and simulation would be good to improve the proposed research plan and suggested an improvement to the future work would also be a slide on the structured method by which the future work goals will be accomplished. The reviewer stated it may be an educational improvement to clarify what is known and is the starting point and what has been learned through this project. The reviewer also questioned if there were any statistical significance tests that have been performed

Reviewer 2:
The reviewer commented that it looks like the work to optimize dilution for the nickel oxide and copper oxide (NiO and Cu_2O) systems is well understood and will be addressed. The reviewer suggested that more work should be included to address the ability to actually apply this method to more than laboratory specimens, and to begin to address corrosion issues.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that dissimilar material joining is considered one of the most important technical barriers to the multi-material lightweight vehicle

Reviewer 2:
The reviewer commented that this could potentially aid in reducing vehicle weight by facilitating joining of dissimilar metals.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that funding appears sufficient to achieve goals.

High Strength, Dissimilar Alloy Aluminum Tailor-Welded Blanks: Yuri Hovanski (Pacific Northwest National Laboratory) - lm099

Presenter

Yuri Hovanski, Pacific Northwest National Laboratory.

Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

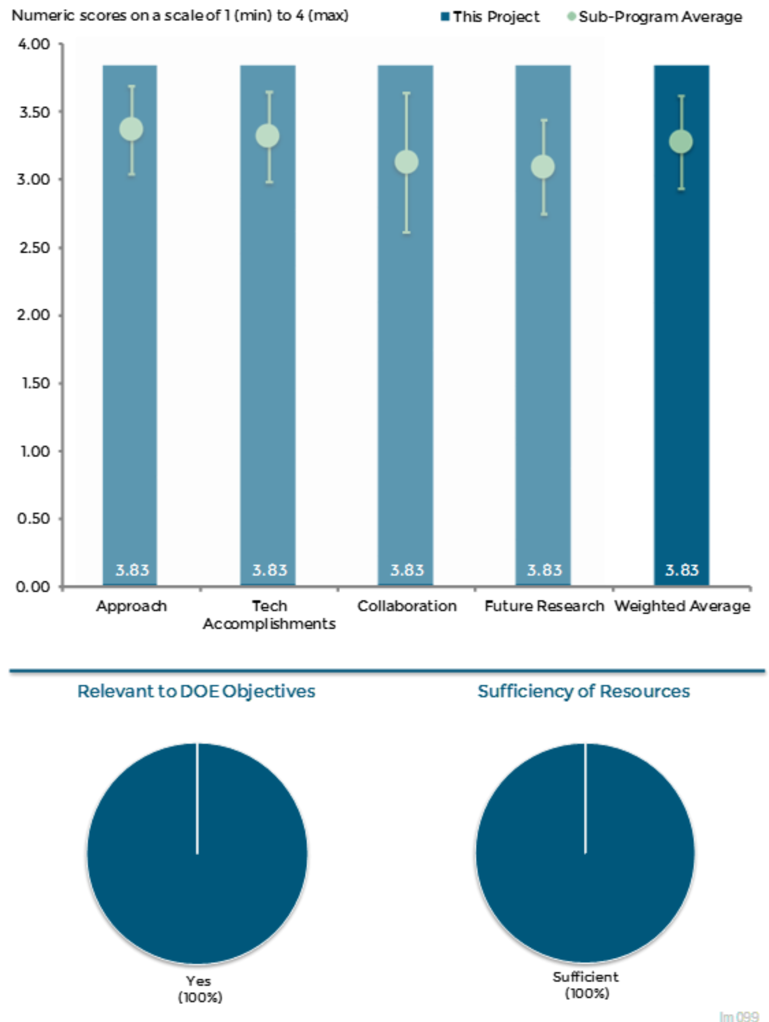

Figure 6-25 High Strength, Dissimilar Alloy Aluminum Tailor-Welded Blanks: Yuri Hovanski (Pacific Northwest National Laboratory) – Lightweight Materials

Reviewer 1:

The reviewer praised the approach as outstanding relating it includes all major tasks to overcome all barriers to adoption including cost, joint strength performance, as well as modeling and simulation that can be used by the process user to a to optimize and adapt to future changes, geometry changes, and process consistency for production readiness.

Reviewer 2:

The reviewer praised the approach of including fully the automotive supply chain and testing production intent geometries as a great approach for the project. The reviewer emphasized that the four-phase technical approach will address the critical issues with this enabling technology.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer related that the project is ahead of schedule and introducing a more complex model to enhance the accuracy of the simulation models. The reviewer related that the project team had completed initial investigation on curvilinear welding.

Reviewer 2:

The reviewer praised the results on the temperature measurements and the heat affected zone as great. The reviewer suggested it would be good in future Annual Merit Review presentations to clearly tie project technical accomplishments to the presented four-phase, multiple step project plans and noted that beginning to characterize the material properties of the friction stir welding (FSW) weld material area is highly valuable

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer praised the collaboration with the material supplier, Alcoa, the process user, TWB, and the end customer, GM, as excellent, offering that they help drive the project forward, and also identify the acceptability of the results and the desirability of certain processing conditions to help the research team identify problems that need to be overcome. The reviewer relayed the example of adding Barlat coefficients into consideration.

Reviewer 2:

The reviewer commented that there was strong collaboration throughout the automotive supply chain.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that there was a strong plan for future work to address the project research.

Reviewer 2:

The reviewer suggested it would be an improvement to see a table of success metrics, values, and milestones and when they will be accomplished.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that rapid, low-cost joining technologies for advanced automotive materials will help accelerate the adoption of lightweight materials.

Reviewer 2:

The reviewer commented that tailor welded Al blanks give the design engineer more flexibility to optimize the part weight.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that funding appears sufficient to achieve goals.

Upset Protrusion Joining Techniques For Joining Dissimilar Metals: Steve Logan (Fiat Chrysler Automobiles US LLC) - lm100

Presenter

Steve Logan, Fiat Chrysler Automobiles US LLC.

Reviewer Sample Size

A total of three reviewers evaluated this project.

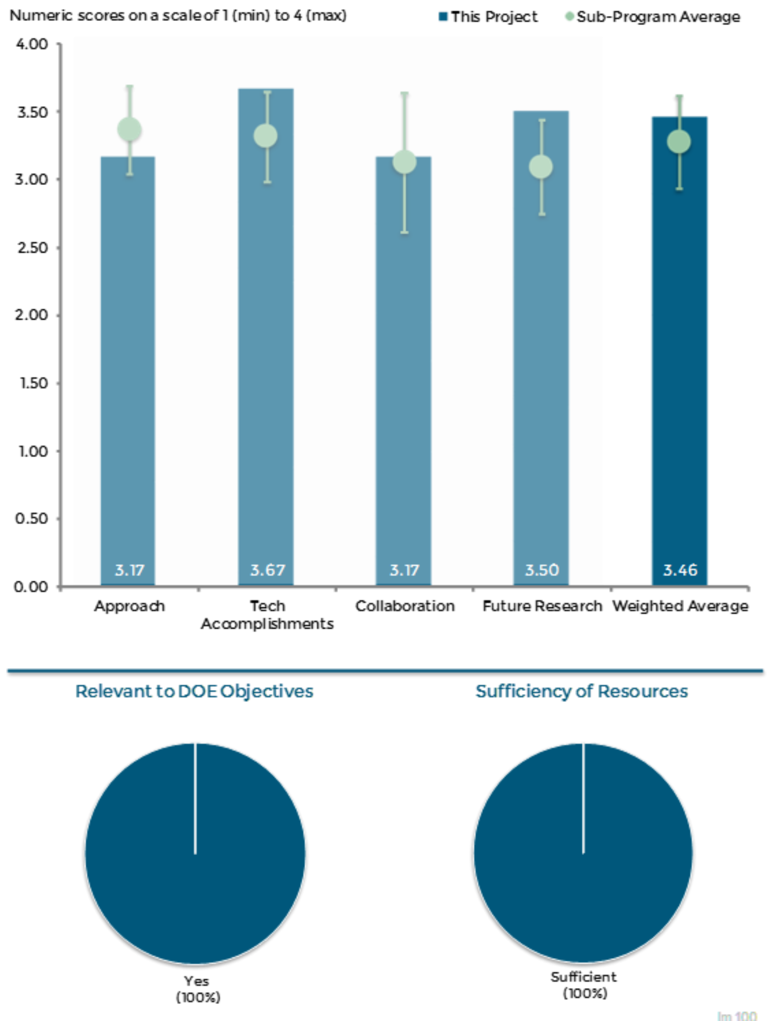

Figure 6-26 Upset Protrusion Joining Techniques For Joining Dissimilar Metals: Steve Logan (Fiat Chrysler Automobiles US LLC) – Lightweight Materials

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said the approach to develop the upset protrusion joining technique for mixed material joints is creative and exciting.

Reviewer 2:

The reviewer commented that a challenge to the use of cast Mg is the joining to other materials. The reviewer further related that in response to this challenge, the team has developed a mechanical joining process using in-cast protrusions. The reviewer acknowledged that comparing this new technique to other mechanical bonding, self-pierce riveting (SPR), is a good idea and cautions that this process cannot be used if the material is not cast.

Reviewer 3:

The reviewer said it appears to be an important project with enough experiments to obtain reliable statistics.

Question 2: Technical Accomplishments and Progress toward overall project and DOE goals—the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewer 1:

The reviewer commented that the amount of work done is astonishing and the team should be commended.

Reviewer 2:

The reviewer explained that the qualification of the process is ongoing and it is as planned.

Reviewer 3:

The reviewer commented that the team has characterized the standard joints as a baseline for the benchmark for the future testing of mixed material joints and praised the work on the Mg to Al joins as a fantastic accomplishment. The reviewer offered that the 650 trials shows the dedication of the team to producing high quality, valid results. The reviewer suggested including a dimensional tolerance study to help increase the manufacturability of the process.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that the supply chain is included in the project.

Reviewer 2:

The reviewer commented that it is all internal to FCA and would have preferred if others had joined the project.

Reviewer 3:

The reviewer commented that the cross functional team, including a coating finisher and a coating supplier, indicates the collaborative nature of the project team.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that corrosion is indeed very important and the reviewer hoped that the team will continue to work with the same care and diligence.

Reviewer 2:

The reviewer commented that the proposed work addresses all the areas of the technical development plan.

Reviewer 3:

The reviewer summarized that the future plan includes corrosion testing and other shapes and suggested it may be interesting to see whether this technique can be extended to other cast alloys including Al. The reviewer also surmised that the investigation can extend to use free standing protrusions for other wrought materials.

Question 5: Relevance: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that joining and corrosion of mixed material joints is a key enabler for lightweight vehicle designs.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that resources would be insufficient if another carmaker had been involved.

Acronyms and Abbreviations

3-D	Three Dimensional
Al	Aluminum
ARL	Army Research Lab
BIW	Body in white
CF	Carbon fiber
CFC	Carbon fiber composite
CO2	Carbon Dioxide
Cu	Copper
DOE	Department of Energy
FBCC	Front bumper and crush can
Fe	Iron
FOA	Funding Opportunity Announcement
FY	Fiscal Year
GATE	Graduate Automotive Technology Education
H2	Hydrogen
ICME	Integrated Computational Material Engineering
LCA	Life-cycle analysis
LCCF	Low-Cost Carbon Fibers
Mg	Magnesium
MMV	Multi-material vehicle
Nd	Neodymium
NF	Nanofiber
Ni	Nickel
NSF	National Science Foundation
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory
PI	Principal Investigator

PNNL	Pacific Northwest National Laboratory
RE	Rare earth
TARDEC	Tank Automotive Research Development and Engineering Center
USAMP	United States Automotive Materials Partnership
VTO	Vehicle Technologies Office

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