

# Magnesium Research in the Automotive Lightweighting Materials Program

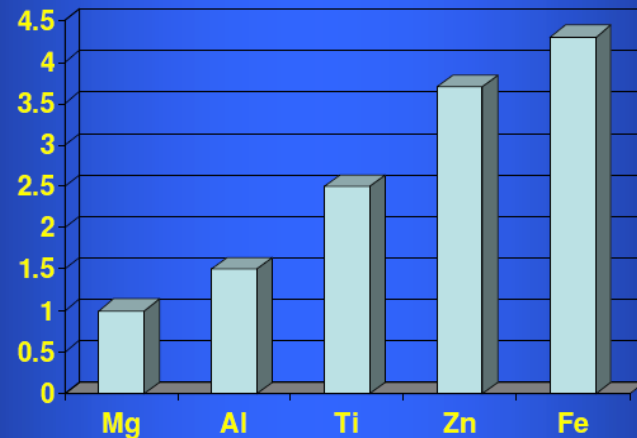


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# Why Magnesium?

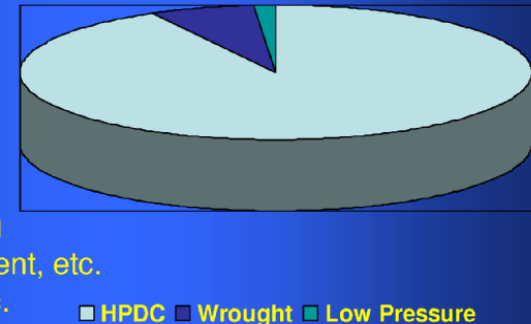
- **Atomic Number 12, Group IIA**
- **Natural Occurrence**
  - Ores (dolomite, magnesite, serpentine, and carnallite)
  - Chloride (sea water, underground brines and salt deposits)
- **Abundance**
  - Eighth most abundant element in the Earth's crust
  - Sea water contains 12 billion pounds per cubic mile
- **Metallic magnesium produced by**
  - Electrolysis of  $MgCl_2$
  - Thermal Reduction of  $MgO$
- **Lightest Structural Metal**
  - ~30% less dense than Al
  - ~80% less dense than Fe
- **High Strength to Weight ratio**
- **Excellent Damping Capacity**
- **Reduced Manufacturing Cost Compared to Other Materials**

## Relative Weights of Metals



## Magnesium Processing

- **Wrought**
  - Extrusion
  - Forging
  - Rolling
- **Low Pressure Molding**
  - Sand, Investment, etc.
  - PM, LPPM, etc.
- **High Pressure Molding**
  - Die Casting
  - Semi-solid Molding



# Magnesium Use in Automotive Applications— Past, Present, Future

- **1920's - Dow Chemical produced Demonstration Trucks with Mg Sheet and Extruded Components**
- **1930's to 1960's – VW used > 40lbs of Mg, primarily in transmission and air-cooled engine**
- **1952 – Stamped Mg Corvette Hoods**
- **1955-1965 – International Harvester produced 6300 Metro-Light Trucks Containing Mg Sheet and Extrusions**
- **1989-1995 – Instrument Panel Cross Car Beams**
- **1998 - Ford PNGV Demonstration Vehicle Contained 87 lbs of Mg Components**
- **2003 - Ford F150 Mg Radiator Support/Carrier**

**Between 30 and 40 components weighing ~ 300 lbs. have been approved for use by OEMs at various times. Over the last 15 years magnesium use has grown at a rate of ~12% per year.**

**But**

**In 2004 the average amount of Magnesium used by Big 3/NA was 12lb/vehicle compared to 260 lbs. of plastic, 280 lbs. of Aluminum, and 2150 lbs of steel and cast iron.**

**Why?**

# Barriers to Increased Use of Mg in Automotive Applications

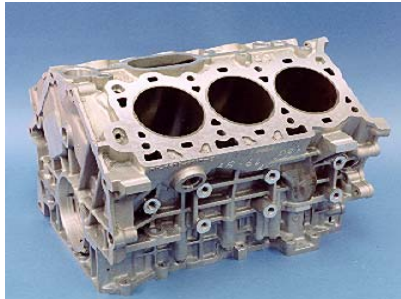
- 1. Perceived High Cost**
- 2. Difficult to Form at Room Temperature**
  - HCP crystal structure
- 3. Variable Quality of Die Castings**
- 4. Corrosion**
  - Galvanic Corrosion
  - General Corrosion
- 5. Fastening and Joining, especially to other materials**
- 6. Recyclability**
- 7. Relatively little R&D on Mg Alloys and Processing During the Last 50 Years**
- 8. Few Industrial Champions and No Full Service Tier 1 Suppliers**

# Strategy for the Future

- **The Automotive Lightweighting Materials Program, in cooperation with the United States Automotive Materials Partnership and the FreedomCAR Materials Technical Team, seeks to achieve FreedomCAR Goals**
  - **50% Mass Reduction**
  - **Affordable Cost**
  - **Increased Use of Recyclable/Renewable Materials**
  - **Comparable Safety and Performance**
- **The OFCVT Multi-Year Program Plan, the FreedomCAR Materials Roadmap, and the USAMP Magnesium 2020 Strategic Vision have all developed intermediate and long term goals and research objectives.**
- **Based on identified needs, specific strategies have been put into place to overcome technical barriers.**
- **Specific research needs include:**
  - **Affordable creep resistant and corrosion resistant magnesium alloys**
  - **Improved processes for producing high integrity castings**
  - **Large magnesium cast structures**
  - **Mg-based metal matrix composites**
  - **Fastening and joining technologies**
  - **Durable protective coatings or corrosion mitigation**
  - **Low-cost formable sheet materials and forming technologies**
  - **Low-cost, high-strength energy absorbing extrusions and forgings**
  - **Methods of processing recycled magnesium**

# Examples of Past/Current Efforts to Support Mg Technology Development Through DOE Funded Projects

- Structural Cast Mg Development (SCMD)



- Magnesium Powertrain Cast Components (MPCC)

- High Integrity Mg Automotive Castings (Hi-MAC)



- Mg Front-End R&D (MFERD)

- Warm Forming Mg Sheet