



**Argonne**  
NATIONAL  
LABORATORY

*... for a brighter future*



U.S. Department  
of Energy

UChicago ►  
Argonne<sub>LLC</sub>

A U.S. Department of Energy laboratory  
managed by UChicago Argonne, LLC

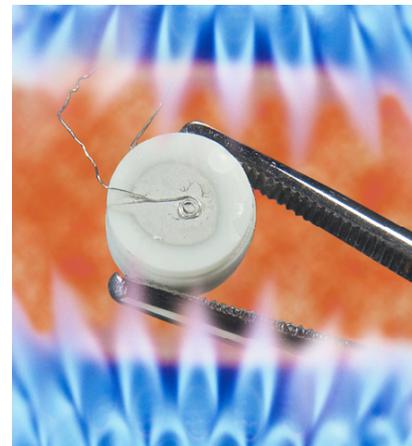
# *High-Temperature Zirconia Oxygen Sensor with Sealed Metal/Metal Oxide Internal Reference*

**Jules Routbort and Dileep Singh,  
Energy Systems Division, Argonne National  
Laboratory**

**Argonne, IL 60439**

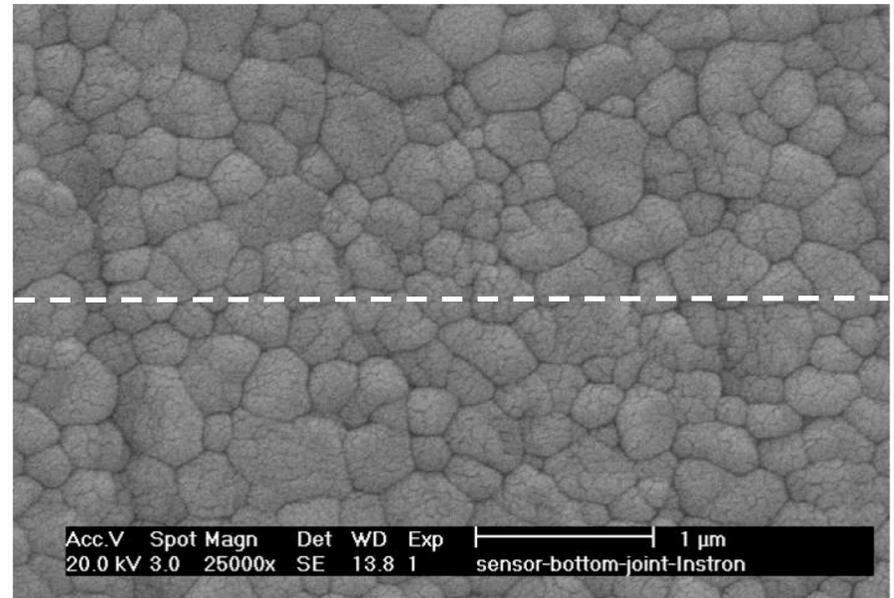
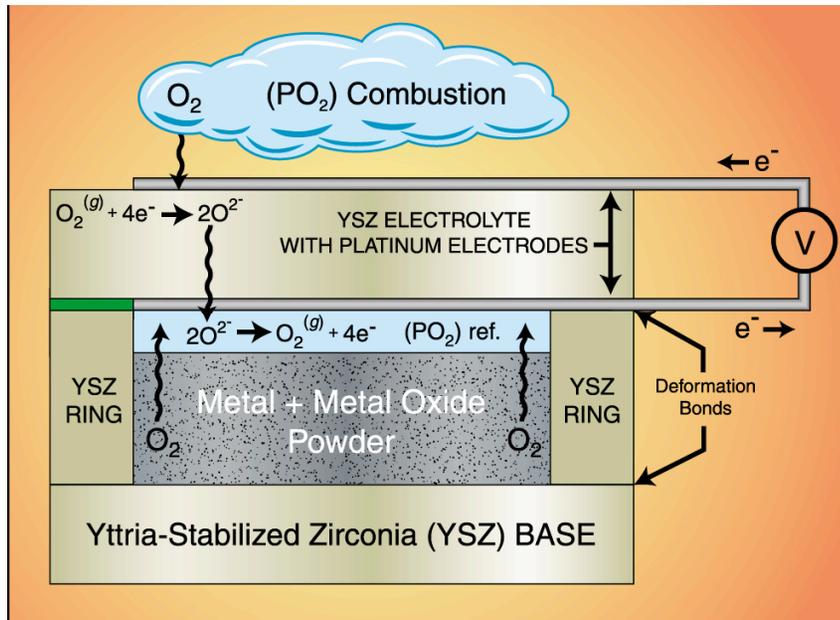
**John Spirig and Prabir Dutta,  
Chemistry Department, Ohio State University  
Columbus, OH 4320**

***P5 – Next to Bar***



# Application based on ANL Patent “Joining by Plastic Deformation”

- Ceramics, intermetallics, composites joined by grain-boundary sliding,  $T \leq 0.5T_m$ , no surface preparation, low stress,  $\epsilon \leq 0.05$
- Boundary shows no porosity
- Fracture occurs away from the joint



Work supported by the U.S. DOE, Office of FreedomCar and Vehicle Technologies