Pacific Northwest National Laboratory

Operated by Battelle for the U.S. Department of Energy

Superplastic Forming of Sheet Materials

Importance of Our Work

Our researchers have optimized Superplastic Forming of aluminum and other sheet-metal materials for lightweight transportation structures. They have reduced the cost ofSPF-grade aluminum sheet and increased forming ratesthrough material and process improvements.

Benefits

- **Reduced weight for high fuel efficiency**
- **Improved structural performance**
- **Increased metal formability and part complexity**
- **Near net shape forming of complex shapes reduces part count**
- **Cost/weight savings**
- **Low-cost tooling**
- **Low environmental impacts - non-lead die lubes, low noise**

Project Participants

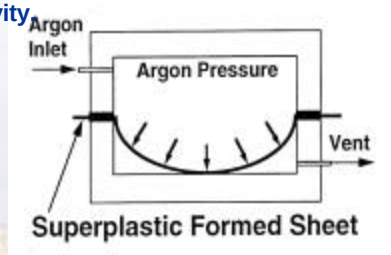
Industry – Boeing, General Motors, Kaiser Aluminum, MARC Analysis, NASA

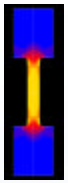
National Lab – Pacific Northwest National Laboratory

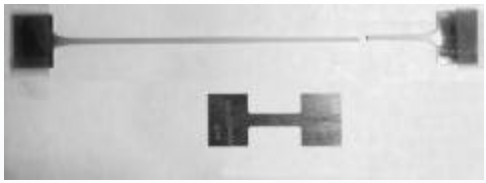
University – University of Michigan, Washington State University

Superplastic Forming

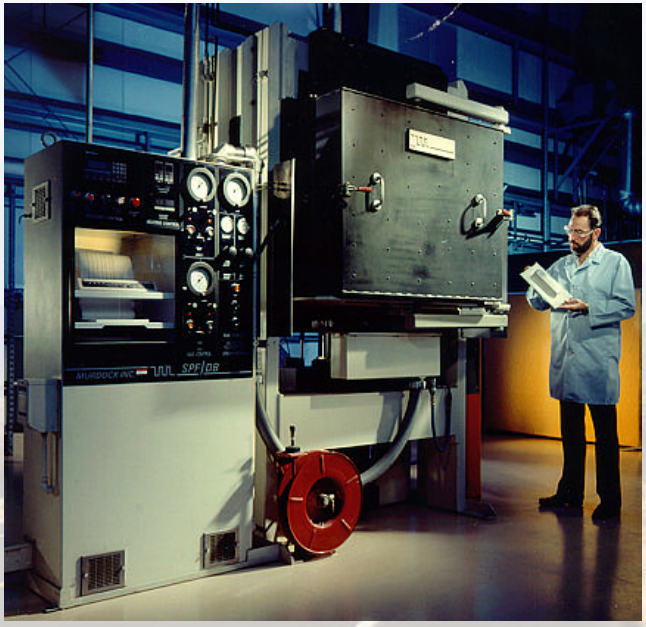
The superplastic forming operation occurs at an elevated temperature, where the flow stress of the sheet material is low. The sheet to be formed is placed in an appropriate SPF die, which can have a simple to complex geometry, representative of the final part to be produced. The sheet and tooling are heated and then a gas pressure is applied, which plastically deforms the sheet into the shape of the die cavity.



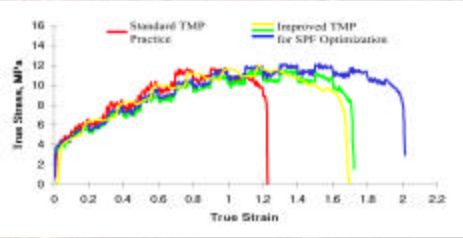




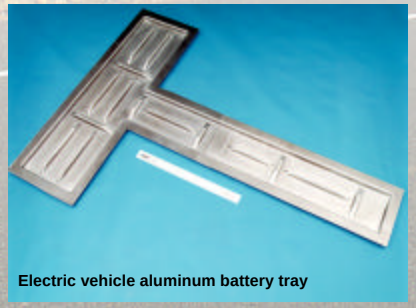
Accurate mechanical test methods help develop material constitutive relationships and process models.



Superplastic forming press evaluates new materials and optimized forming cycles.

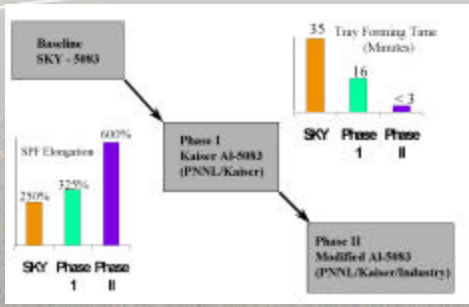


Improvements to sheet material thermal mechanical processing leads to an increase in superplasticity performance.

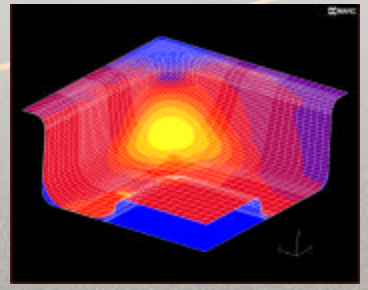


Electric vehicle aluminum battery tray

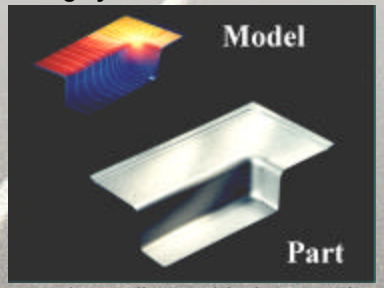
Superplastic forming can produce complex shapes with stiffening rims and other structural features.



Lower cost modified aluminum alloys with SPF properties have been developed with significantly better formability characteristics.



Development of forming models help predict deformation, flow stress, microstructural evolution, and cavitation. Finite element analysis, with solution control algorithms help to optimize SPF behavior.



Forming trails provide for experimental validation of producing SPF parts based on model predictions of optimized forming cycles.

DOE-EE-OTT, Office of Heavy Vehicle Technologies; DOE-EE, Office of Laboratory Technology Research