Continuous Severe Plastic Deformation (CSPD) Process for Aluminum Alloys

The Department of Energy (DOE), as part of the Industries of the Future – Aluminum Initiative, recently funded a $2.5 million three-year program for the development of a new Continuous Severe Plastic Deformation (CSPD) process. The research team, led by Prof. Raghavan Srinivasan, Department of Mechanical and Materials Engineering, Wright State University (WSU), includes Intercontinental Manufacturing (IMCO), Garland, Texas, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee, and the Edison Materials Technology Center (EMTEC), Kettering, Ohio. This program will develop a prototype of the CSPD process for producing ultrafine grain aluminum, and demonstrate the energy and cost savings associated with using ultrafine grain aluminum as forging stock. Upon successful completion of the program, a new generation of materials for a variety of applications, such as those in the aerospace and automotive industries, will become available.

The use of ultrafine grain materials has the potential of solving a number of industry challenges by

- Lowering the forging and extrusion temperature and decreasing the energy requirements for heating the workpiece.
- Increasing the life of dies, and permitting the use of less expensive die materials
- Lowering the forging and extrusion pressures, thereby reducing the press tonnage required for large parts.
- Increasing yield, and making nearer to net shape parts.
- Improving the fatigue properties and the strength of metallic parts when the forging or extrusion process is controlled to retain the fine microstructure.
- Improving the machinability of stock material.

At this time ultrafine grain materials are available in very small sizes and in quantities that have no significance to the metal processing industry. The CSPD process, conceptualized by Dr. Srinivasan, and collaborators Dr. Prabir Chaudhury (IMCO) and Dr. Srinath Viswanathan (ORNL), will be able produce ultrafine grain aluminum in a continuous or semi-continuous fashion. The new process is capable of imparting large plastic strains, equivalent to that imparted by extrusion with a reduction in area of 300 to 1. Such severe plastic deformation has been shown to produce grains in the size range of 10 μm to 10 nanometers.

The overall cost of the program includes a 50% cost share provided by IMCO, WSU and EMTEC. WSU will perform the process simulations and materials characterization associated with the design and development of the process, ORNL will develop a lab-scale prototype of the process, IMCO will develop the forging processes required to demonstrate cost and energy savings, and EMTEC will help in the transfer of technology through its industrial members. The Air Force Materials Laboratory (AFRL) has also agreed to support the program through the use of their Deformation Processing Facility.

Link to Department of Energy Fact Sheet