Forming Of Lightweight Material For Automotive Applications

Automobile manufacturing is a materials intensive industry that involves about 10% of the U.S. workforce. In spite of the use of the most advanced, cost-effective technologies, this globally competitive industry still has productivity issues related to measurement science and data. Chief among these is the difficulty encountered in die manufacture for sheet metal forming. In a recent Advanced Technology Program-sponsored workshop (The Road Ahead, June 20-22, 2000, at USCAR Headquarters), the main obstacle to reducing the time between accepting a new design and actual production of parts was identified as producing working die sets. This problem exists even for traditional alloys with which the industry is familiar. To benefit from the weight saving advantages of high strength steel and aluminum alloys, a whole new level of formability measurement methods and data is needed, together with a better understanding of the physics behind metal deformation.

This program is meeting these industrial needs by developing (1) standard formability test methods, (2) models for surface roughening and friction during stamping, (3) multiscale, physically-based constitutive laws, (4) models for anelasticity and springback prediction and (5) measurements of texture and residual stress evolution. Our recently established sheet metal formability laboratory is now adding *in situ* X-ray equipment for measuring stress in sheet metal samples during multiaxial deformation. This laboratory permits us to investigate industrially important measurement problems in formability and pursue standard test methods for formability. The facility provides test samples of multiaxially deformed metal for other aspects of this program. For example, deformation-induced surface roughening of sheet metal is a poorly understood phenomenon that is highly relevant to industry. We are currently performing controlled experiments on multiaxially strained sheets to develop a surface roughening database and a generic model which industry has identified as a high priority need. The test methods and surface roughening projects were selected by the Industrial Liaison Office of NIST for a pilot survey aimed at obtaining comprehensive, non-biased feedback from industry. They received high scores on all aspects including industrial relevance and potential impact. On a more fundamental level, MSEL's advanced characterization capabilities (TEM, AFM, Synchrotron Radiation, NCNR) are being used to understand the basic dislocation patterning responsible for the observed behavior of metals. A predictive model based on percolation theory has been developed from the measurements and observations. All aspects of the research at NIST will impact our customers by improving the commercially available, finite element computer codes that are heavily used by this industry. A key element in the design of this program is that an insight or advancement gained in one area can be immediately used in a piecewise fashion in the design process, i.e., total success of the program is not required to have an impact. Other means of transferring this technology, such as through standardizing organizations and by direct interaction with industrial counterparts, are being pursued. While targeting the auto industry, our research will have extended applications to all other industries that employ metal forming in their production lines.