

# Multi-scale Modeling of Deformation during Metal Forming

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New materials are needed to meet the rapid evolution of technology in a variety of industries. Unfortunately, the Edisonian approach of testing multiple variants of a material until a suitable composition or thermo-mechanical process is identified takes too long, and results in a 7- to 10-year cycle for implementation of a fully validated, new material. Multi-scale modeling has become one of the “buzz words” to describe the ability to model properties of materials using a variety of calculations at different length scales. Much of the multi-scale research is intended to speed up the process of material design by performing virtual experiments. Multi-scale modeling is a key element of the Integrated Computational Materials Engineering initiative,<sup>1</sup> which relies on many of these calculations to develop and validate engineering solutions.

The following set of papers provides three examples of how multi-scale modeling can be used to better understand metal deformation. The papers were selected and reviewed by the TMS Shaping and Forming Committee.

In “Atoms to Autos: A Multi-scale Approach to Modeling Aluminum Deformation,” P.E. Krajewski, L.G. Hector, Jr., Y. Qi, R.K. Mishra, A.K. Sachdev, A.F. Bower, and W.A. Curtin describe the results of an extensive re-

search program to develop microstructurally informed constitutive equations for aluminum sheet forming at room and elevated temperature.

In “Multi-scale Modeling of Low-temperature Deformation in b.c.c. Metals,” Thomas E. Buchheit, Corbett C. Battaile, Christopher R. Weinberger,

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and Elizabeth A. Holm describe a multi-scale approach where atomistic information is used in single- and poly-crystalline plasticity calculations to study the effect of microstructure on

yield surfaces and tensile behavior.

Finally, in “A Full-field Strategy To Take Texture-induced Anisotropy into Account During FE Simulations of Metal Forming Processes,” Paul Van Houtte, Jerzy Gawad, Philippe Eyckens, Bert Van Bael, Giovanni Samaey, and Dirk Roose demonstrate a full-field approach to incorporate complex descriptions of texture, into models, which can accurately predict earing behavior during deep drawing of sheet steel.

These papers demonstrate that while there are many approaches to “multi-scale modeling,” they all provide the framework to link lower length scale information with large scale calculations and solve real world engineering problems.

## References

1. John Allison, Dan Backman, and Leo Christodoulou, *JOM*, 58 (11) (2006), pp. 25–27.

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Mark R. Stoudt, Paul E. Krajewski, Michael P. Miles, & John E. Carsley are TMS Members!

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