Summer, 2009

Volume 7, No. 3

DEFORM™ News

Events:

- November 3 & 4, 2009 (tentative): The Fall DEFORM User Group Meeting will be held at a location to be announced.

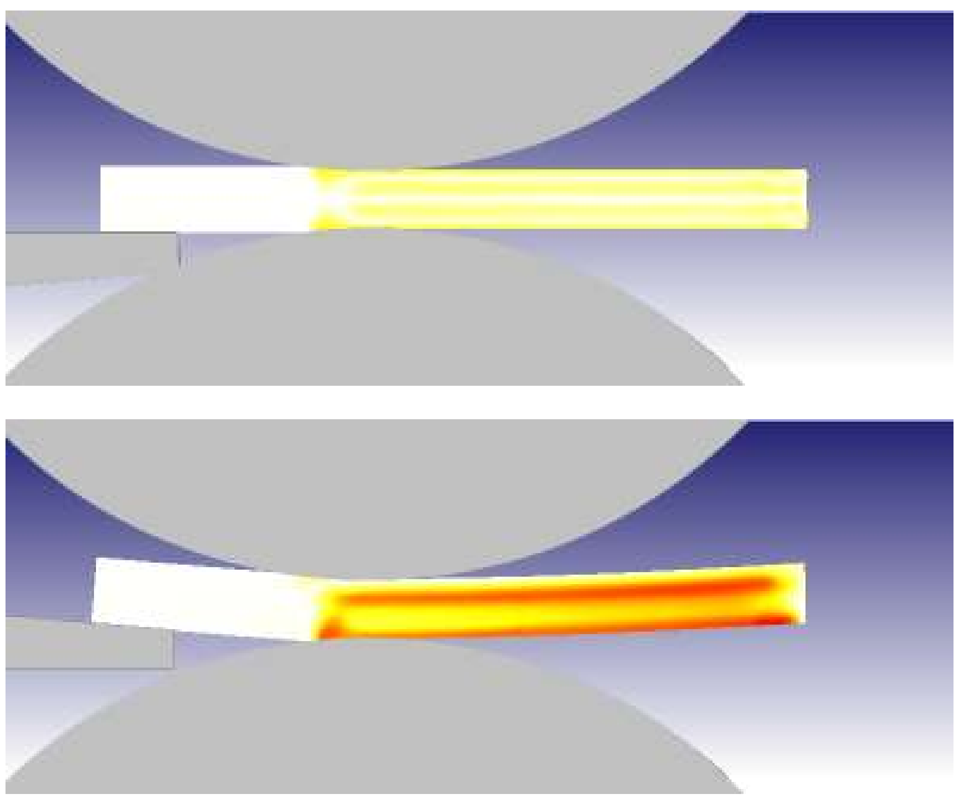
Training:

- July 14 & 15, 2009: DEFORM-2D training (includes DEFORM-F2) will be conducted at SFTC in Columbus, Ohio.
- July 16 & 17, 2009: DEFORM-3D training (includes DEFORM-F3) will be conducted at the SFTC office.
- September 22 & 23, 2009: DEFORM-2D training (includes DEFORM-F2) will be conducted at SFTC in Columbus, Ohio.
- September 24 & 25, 2009: DEFORM-3D training (includes DEFORM-F3) will be conducted at the SFTC office.

Sputtering Targets

H.C. Starck is one of the world’s largest producers of refractory metals, including tantalum. Among other products, they supply materials for sputtering processes. Sputtering is a physical vapor deposition (PVD) process used in electronics manufacturing. The source “target” is typically a plate or disk of high purity metal less than an inch thick. An ion beam or plasma is used to dislodge atoms from the target, which are redeposited in thin layers on electronic components. To attain consistent thickness and quality in the deposition process, the crystallographic “texture” of the target must be very uniform.

Texture is a description of the crystallographic alignment of the grains of a material. During target manufacturing, the texture evolves as deformation is induced. H.C. Starck uses a rolling process to modify microstructure while attaining a desired product shape. Traditional rolling processes produced a gradient in texture between the surface and the mid-thickness of the rolled plate. H.C. Starck employed DEFORM simulation to understand the root cause of texture gradient in tantalum plate, and to investigate alternative processing methods to produce suitable shapes with minimal texture gradient.



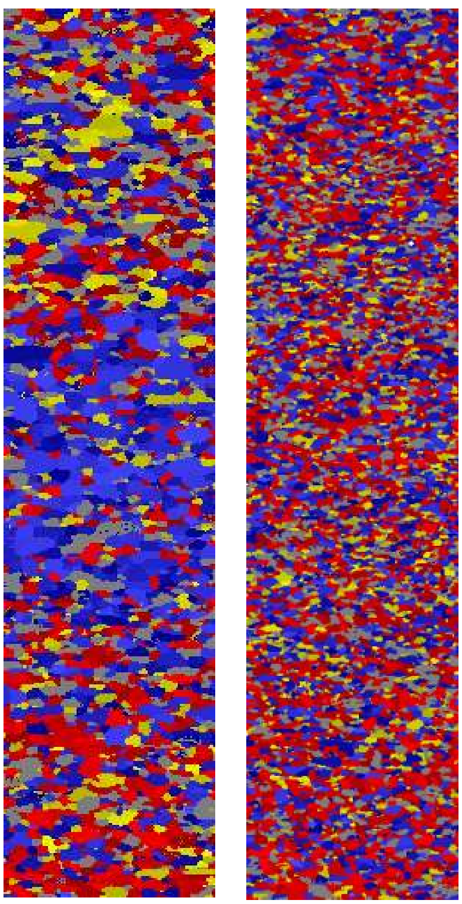
Shear strain distribution predicted in conventional rolling (top) and tilt rolling (bottom), where red represents high strains. Tilt rolling introduces desirable shear strain at the mid-thickness of plate.

DEFORM™

Design Environment for FORMing

In order to study texture, DEFORM was coupled with a VPSC model (Visco-Plastic-Self-Consistent, a crystal plasticity model developed by Carlos Tome at Los Alamos National Lab). Crystal plasticity models provide a means to predict texture evolution as a function of strain components and initial texture. They identify crystallographic “slip planes” and compute deformation and rotation of grains in response to stress and strain fields.

DEFORM-2D simulations of the conventional rolling process showed uniform normal strains through the thickness. However, shear strains were high near the surface and quarter-thickness, but near zero at the mid-thickness. When the shear and normal strain components are introduced into the VPSC model, the results showed strong texture at mid-thickness with more distributed texture approaching the surface.



EBSD images show texture through the thickness of plates rolled with conventional (left) and tilt rolling (right).

This was consistent with experimental observations and suggested shear strain is the driving factor in texture development.

A range of alternative processes were studied in DEFORM-2D. Asymmetric roll configurations, including 2:1 differences in roll diameter, and 4:1 differences in roll speed were investigated. As a result of the practical difficulties of these processes, a novel process named “tilt-rolling” was developed. In this process, a special fixture is used to feed the plate into the rolls at an angle. Simulation results showed that tilt-rolling is a very effective way of introducing shear strain in the mid-thickness plane of the workpiece. VPSC models indicated a much more uniform texture distribution.

Physical test samples examined using Electron Back Scatter Diffraction (EBSD) microscopy verified the model results. EBSD images, as shown at the left, display texture orientation as colors. The more uniform color distribution in the tilt-rolling sample is consistent with a more desirable texture.

After five years of research with DEFORM and crystal plasticity models, H.C. Starck achieved a new tantalum sputtering target with superior texture uniformity. This product is now available in the marketplace. Two patent applications (WO/2009/200619 for tilt rolling and US20090038362 for the tantalum sputtering target) have resulted from this research. The tilt rolling process is available for licensing to companies working with materials other than refractory metals: contact Dincer Bozkaya at dincer.bozkaya@hcstarck.com.

SFTC would like to thank Dincer Bozkaya and Peter Jepson of H.C. Starck for their contributions to this article.

Releases:

DEFORM Version 10.0 is being released at this time. This is the first combined release for both 2D and 3D systems. This release includes 2D - 3D integration, a new license manager, multiple material groups and developments in shape rolling and ring rolling.

Quad Core Performance

SFTC recently acquired and tested a computer containing an Intel quad-core processor based on the Nehalem microarchitecture. The system, priced under $1000, offered impressive gains in simulation speed.

In an 80,000 element hot forging benchmark, runtime was 1 hour 24 minutes on the quad-core desktop. By comparison, a one year old dual-core desktop required 2:45 and a four year old dual-processor workstation required 3:08.

Nehalem-based multi-core processors are sold as the Core i7 model on desktop systems and as 35xx or 55xx Xeon models on workstations. For additional details please contact SFTC.

Scientific Forming Technologies Corporation

2545 Farmers Drive
Suite 200
Columbus, OH 43235
Tel: (614) 451-8330
Fax: (614) 451-8325
www.deform.com