Winter, 2012

Volume 10, No. 1

DEFORM™ News

Training:

- April 17-20, 2012: DEFORM training will be conducted at the SFTC office in Columbus, OH.
- June 5-8, 2012: DEFORM training will be conducted at the SFTC office in Columbus, OH.

SFTC has a new format for training:

Tuesday - Wednesday:
Basic DEFORM 2D/3D/F2/F3
Thursday: 2D/3D topics including advanced meshing, elastic plastic analysis, fracture, multiple deforming objects and multiple operations
Friday: Advanced topics based on attendees - may include microstructure modeling, ring rolling, shape rolling, machining or other topics as requested

Contact Chris Fischer at (614) 451-8330 x103 - cfischer@deform.com for details

Events:

- May 8-10, 2012 (tentative): DEFORM User Group meeting will be held in Columbus, OH.
- August 22 and 23, 2012: Die Stress will be held at Marquette University in Milwaukee, WI.

Technical support on the model development for microforming simulations was provided by the UK Distributor, Wilde Analysis.

Citation: R. Kempers, P. Ahern, A.J. Robinson & A. M. Lyons, "Geometry Reconstruction for Finite-Element Modeling using SEM Stereomicroscopy" Computers and Structures, 92-93,(2012) pp. 216-228. doi:10.1016/j.compstruc.2011.11.001

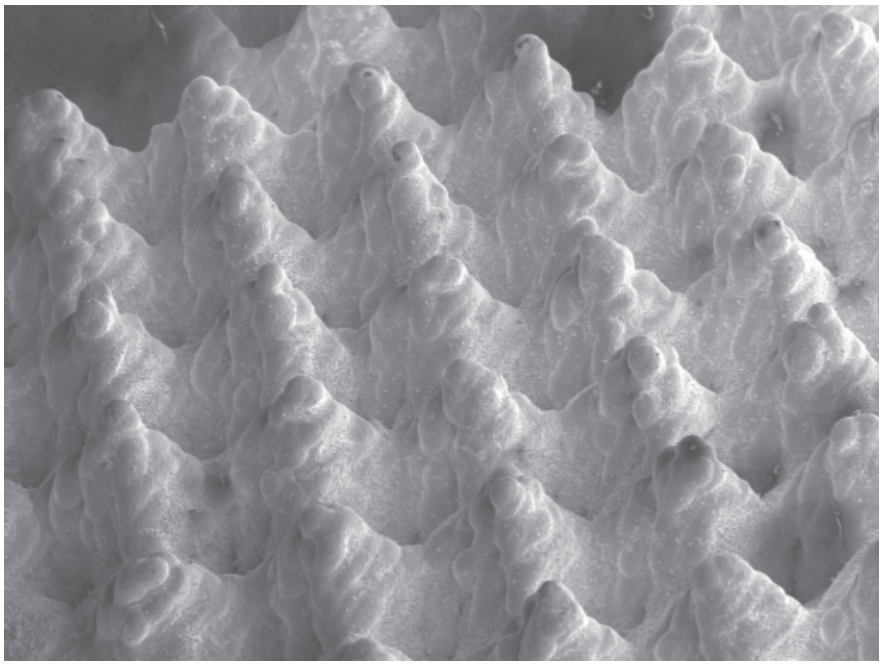
DEFORM™
Design Environment for FORMing

Simulation of Microforming for Thermal Interface Materials

Introduction

Thermal interface materials are used to improve heat transfer between contacting surfaces when good heat transfer is needed, such as between computer chips and cooling fins. Without such an interface material, inherent surface roughness and waviness creates air gaps which impede conduction.

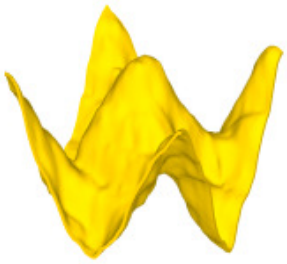
Alcatel-Lucent worked with Trinity College Dublin (Ireland) and the City University of New York - College of Staten Island to investigate a novel micro-textured thermal interface material. The micron scale egg crate like sheet is made from an excellent thermal conductor such as silver. Under clamping, the peaks plastically deform. As the peaks are crushed, the surface conforms to the contacting surface and improves thermal coupling. The shape of the load vs. deformation curve is a key piece key piece of information required for testing and design optimization of the surface.



Challenges

Effectively optimizing the size and geometry of the surface texture features requires an understanding of the compression and buckling behavior of the peaks. Early mechanical models did not match experimental results well. Initial finite element models based on idealized peak shape did not capture the complex buckled shape seen in physical tests.

To accurately characterize the shape of the peak features scanning electron microscope (SEM) stereomicroscopy was used to measure the surface. MeX image processing software (Alicona Imaging, GmbH) was used to reconstruct a 3 dimensional surface from the SEM images. MATLAB (Mathworks, Inc.) was used to convert the surface into a solid suitable for DEFORM-3D meshing.



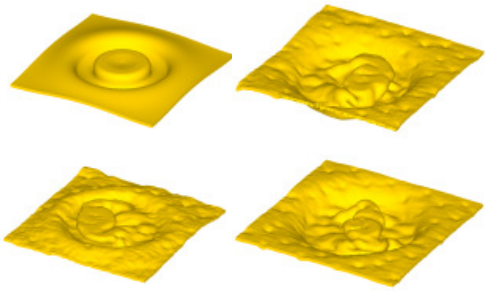
Simulation and Results

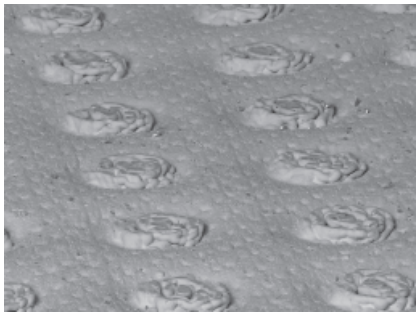
Because the goal of the current project was to study buckling behavior and compression loads, the rigid-plastic material model was adequate. The test material was 99.99% pure silver. A flow stress curve was derived from a standard compression test. A single unit cell geometry was studied, with symmetric boundary conditions assigned to all four sides of the cell. Model sizes of around 150,000 elements were found to provide adequate geometric resolution. Self-contact and local remeshing were used to ensure correct behavior as the surface buckled on itself. For comparison, an idealized unit cell geometry was constructed with a CAD system and simulated using the same procedure.

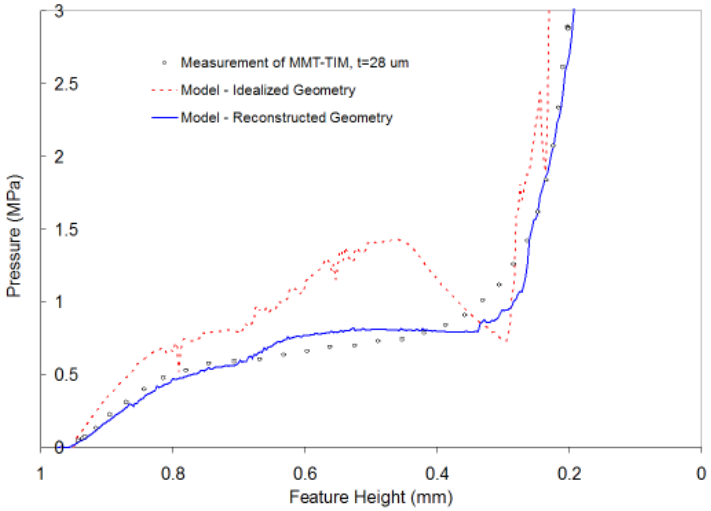
The scanned shape gives excellent qualitative comparison with physical tests. Load-stroke curves also match within 15% of the measured curves. Of note, the idealized shape exhibits substantially different compression behavior. The irregularities present from manufacturing precipitate the non-uniform buckling.

Conclusions

This research shows a novel use of DEFORM for a product 100 times smaller than typical applications. Despite the size difference, key principles are highlighted. DEFORM is capable of matching results of physical testing very well, but the result is dependent on input data. Idealized inputs tend to yield idealized results. While not every simulation requires measurements with an electron microscope, consideration of variability in billet shape, temperature, lubricant, location, alignment and similar factors will yield improved results in any simulation.







Releases:

DEFORM V10.2 was released in August. An updated DEFORM V11.0 (beta) was posted to the User Area in October.

DEFORM V10.2 includes the following major enhancements:

- GUI activation of 64 bit simulations
- 64 bit user subroutine support
- improved batch queue stability
- Centos 5 & Suse 11 support
- dual frequency induction heating in DEFORM-2D
- DEFORM-3D resistance heating
- mesoscale microstructure model

Additionally DEFORM V11.0 (beta) contains:

- enhanced 3D extrusion analysis
- 2D torsion model that supports elastic-plastic materials

SFTC is currently working on DEFORM V10.2.1 which will include:

- MPICH2 for Linux operating systems, Centos4, Centos 5 and Suse11 - for better stability and performance
- improved handling of 3D hydraulic press modeling
- memory handling fixes to handle coupled die stress models using CG solver in MPI mode
- improved handling of models involving multiple sliding dies
- improved handling of arbitrary bath movement controls when applied with torque
- additional movement control for the axial rolls in ring rolling models that allow definition of axial roll position as a function of workpiece diameter
- improvements in 3D view factor computations to allow explicit control of the objects and additional step controls for faster computing speed
- bug fixes

The web posting of V10.2.1 is tentatively scheduled for April, pending successful internal testing.

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