Winter, 2013
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DEFORM™ News

Events:

- March 26-28, 2013: Forge Fair 2013 at the Greater Columbus Convention Center - Hall C, Columbus, OH
- May 21, 2013: DEFORM Distributor meeting in Naples, FL
- May 22-23, 2013: DEFORM User Group meeting in Naples, FL
- Die Stress Workshop - date and location to be determined

Training:

- April 9-12, 2013: DEFORM training will be conducted at the SFTC office in Columbus, OH.
- June 18-21, 2013: DEFORM training will be conducted at the SFTC office in Columbus, OH.
- August 20-23, 2013 **(note - dates changed)**: DEFORM training will be conducted at the SFTC office in Columbus, OH.

DEFORM™
Design Environment for FORMing

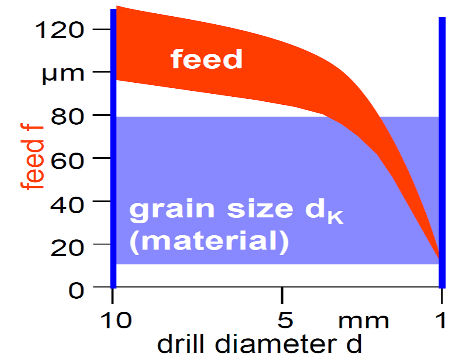
Discrete multi-phase material modeling for micro-machining simulations

Researchers at the WZL and IPT at the RWTH University in Aachen, Germany have demonstrated a new approach to modeling material microstructure effects in micro-machining.

There is a constant push for miniaturization in design and manufacturing. The demand for smaller and smaller devices is driven both by convenience, as evidenced by personal electronic devices, and by weight savings in aerospace and automotive industries.

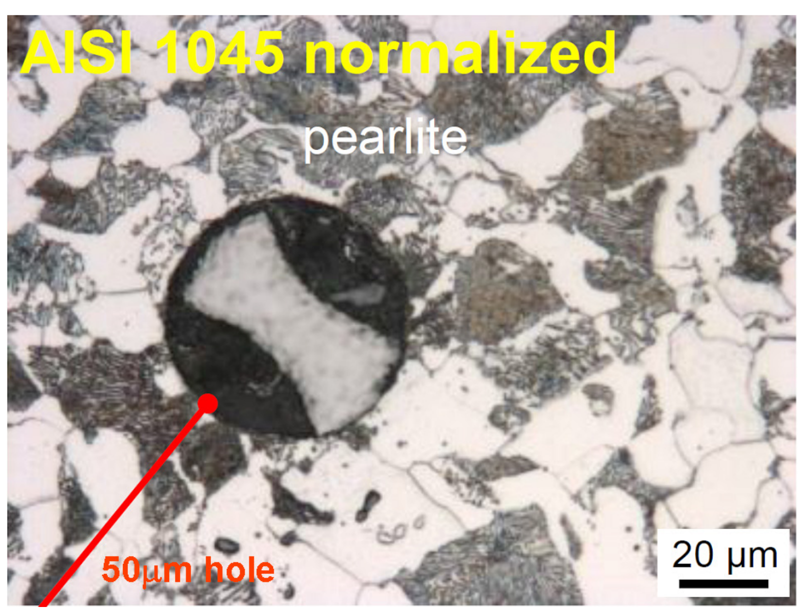
Miniaturized applications include:
- Mobile electronic devices
- Bio-medical implants
- Micro-sensors
- Micro-transmissions
- Precision clockwork-type movements

Micro-devices require micro-manufacturing techniques such as machining. Traditionally, machining workpiece materials have been modeled in DEFORM as continuous, homogenous, isotropic materials. Any point to point variations in base materials have been neglected. Only the influence deformation induced changes in strain and temperature have been considered.



In micro-machining processes such as micro-drilling, holes may be smaller than 100µm. At this scale, chips are significantly smaller than grains and other microstructure features. For example, in a dual-phase steel, the pearlite regions can be up to three times harder than ferrite regions, and those regions are larger than the thickness of the chip.

The assumptions in the standard DEFORM material model do not capture the influence of microstructure features relative to the DEFORM chip. Researchers have developed a multi-phase model wherein the phases are modeled discretely rather than as a mixture. Up to 400,000 elements are used, with phases assigned element by element.



A workpiece was generated with 60% pearlite, 40% ferrite. Each phase was modeled as a discrete material. The flow stress was developed for each phase using a high rate compression test known as a Split Hopkinson Pressure Bar.

Micro-drilling simulations were performed with several drill diameters using the standard DEFORM multi-phase mixture model and the discrete phase element model. These simulation results were compared to experimental studies. A key feature of the experiments was the formation of holes in the chip due to pearlite grain pullout. This pullout effect adversely affects surface finish.

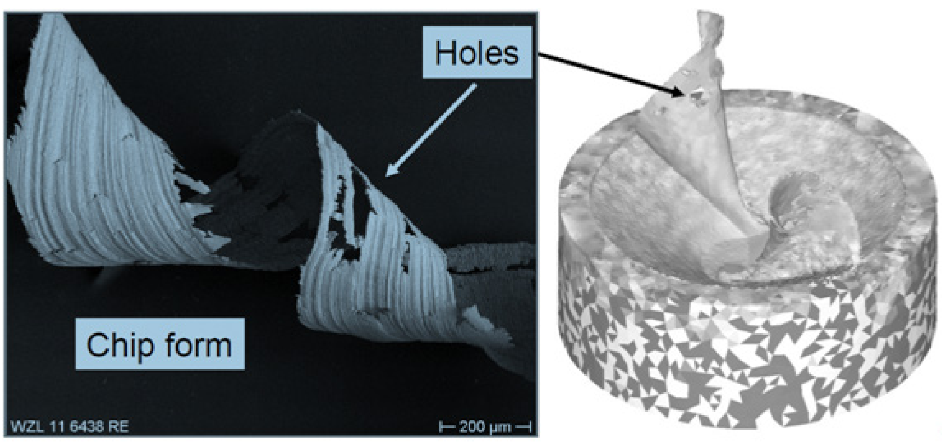
Results of the simulation showed that the discrete phase model gave significantly better prediction of feed force than did the standard model. The discrete phase model also correctly captured holes in the chip, where the standard model did not.

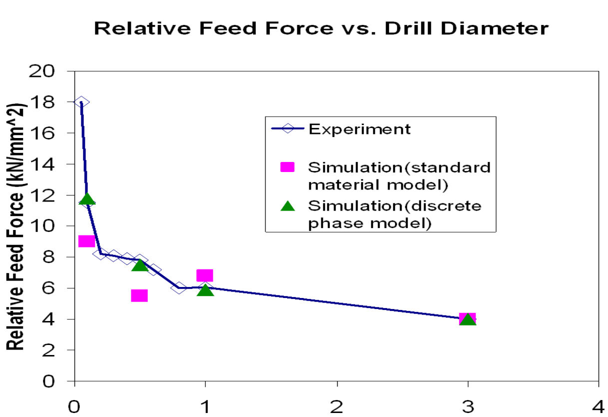
Conclusions

The newly developed modeling approach was successfully validated. The computation of feed forces and torques was improved significantly. Researchers indicate that their future work will extend to other cutting processes such as turning, milling, etc. The possibility of considering grain orientation, inclusions, micro-defects and phase transformation will be studied.

Acknowledgement

This article is based on the work of Dr.-Ing. Mustapha Abouridouane and his colleagues at the Institute for Production Technology (IPT) and the Laboratory for Machine Tools and Production Engineering (WZL) at the RWTH in Aachen, Germany. It was originally presented in January, 2013 at the German speaking DEFORM User Group Meeting.





Releases

SFTC is currently working on DEFORM V11.0, which will feature many major new features:

- A completely redesigned multiple operations pre-processor
- A batch post-processor for automating many post-processing functions
- Multiple operations pre-processor for F2 and F3
- Design of experiments capability to study the effect of varying parameters on a simulation result
- Optimization of geometry and other parameters
- Dramatically enhanced material modeling capabilities, including crystal plasticity and mesoscale microstructure models
- Explicit solver
- 64 bit mesh generation for handling simulations exceeding one million elements
- Improved elastic-plastic convergence with a displacement-based formulation
- Improved ring rolling speed and stability
- Better solver performance on large models

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