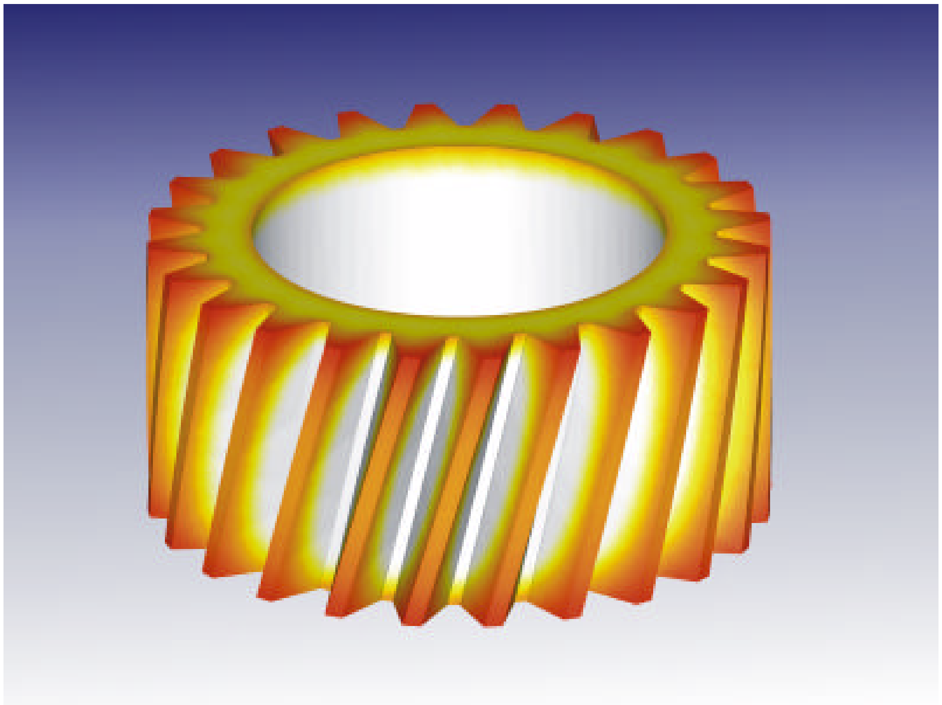
DEFORM™ - HT

Scientific Forming Technologies Corporation

DEFORM-HT is a powerful stand-alone finite element modeling system for simulating heat treatment processes. The system predicts thermal, mechanical and metallurgical responses of parts during heat treatment. Heat treat distortion, quench cracking and residual stresses can be predicted. The system can also provide information on phase transformation and phase volume fraction.

A variety of materials ranging from carbon steel and aluminum to titanium and nickel based alloys can be modeled. Typical heat treatment processes include:

- normalizing	- austenizing	- carburizing	- solution treatments
- quenching	- tempering	- aging	- stress relieving



DEFORM-HT can be used to analyze diffusion processes such as carburization, providing a prediction of case depth. Residual stresses after heat treatment processes can also be predicted. The system can also simulate stress relaxation and aging. Modeling of stress relaxation is important since the residual stresses in the part can significantly impact subsequent machining distortion. Residual stress influences the life of a component in service.

This powerful modeling tool provides critical information about the process variables required to control and optimize heat treatment processes. It provides the ability to visualize the microstructure, temperature and stress during heat treatment. This is simply not possible with experiments. It is possible to conduct sensitivity analysis without the time and cost of physical trials. DEFORM-HT is a tool that enables users to achieve an optimum balance of mechanical properties, while avoiding quench cracks and minimizing heat treat distortion and residual stresses.

Product Specifications

- DEFORM-HT is available as a 2D or 3D stand-alone system.
- Heat transfer, phase transformation and diffusion modules are coupled in an integrated simulation environment.
- Material models include elasto-plastic, thermal elasto-plastic and creep.
- Model outputs include evolution of temperature, cooling rate, residual stresses, distortion, phase volume fraction and hardness.
- Five popular creep models are implemented to simulate the stress relaxation process.
- Multiple heat treat operations can be set up to run sequentially without manual intervention.
- A mixture rule is used to define various phase properties as a function of temperature and primary atom. For example, carbon content is the primary atom in carbon and alloy steel.
- Diffusion based phase transformation kinetics (i.e. austenite to ferrite) is represented by Johnson-Mehl equations and TTT data.
- Diffusionless phase transformations (i.e. austenite to martensite) are represented by Magee equations as a function of temperature, primary atom content and stress.
- Volume change due to phase transformation is accounted for in the model.
- Individual phase hardness or Jominy data is used to predict the global hardness distribution.

DEFORM™

Design Environment for FORMing

DEFORM™- HT

Licensing Options

- DEFORM™-HT can be licensed as a stand-alone 2D or 3D system.
- A **Microstructure Module** can be added to a DEFORM™-2D or DEFORM™-3D license to provide transformation, grain size and diffusion modeling capability. See the example below for more information.

System Requirements

- DEFORM™-HT runs under WINDOWS XP/2000 or on popular UNIX workstations.
- The recommended configuration is 1 GB RAM with at least 50 GB of free disk space and a color printer.
- A read/write CD or DVD is recommended to back up results.
- Internet access is recommended for technical support and updates.

General Information

- Training, support and regular updates are available to active DEFORM™ Users.
- DEFORM™ Users Group meetings are held regularly.
- Outputs include graphics, raw data, hard copy and animations.

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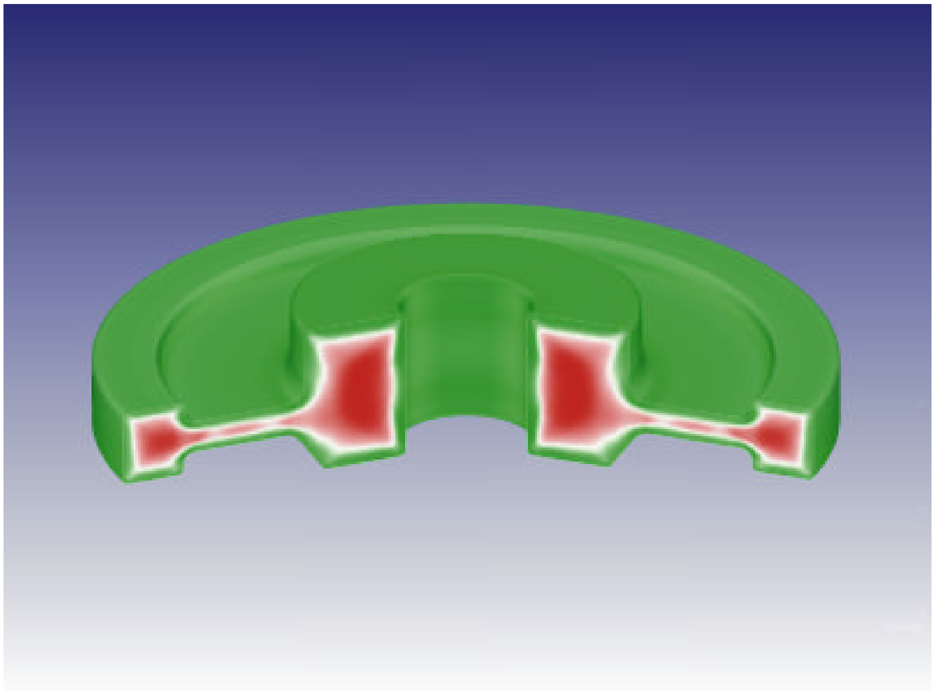
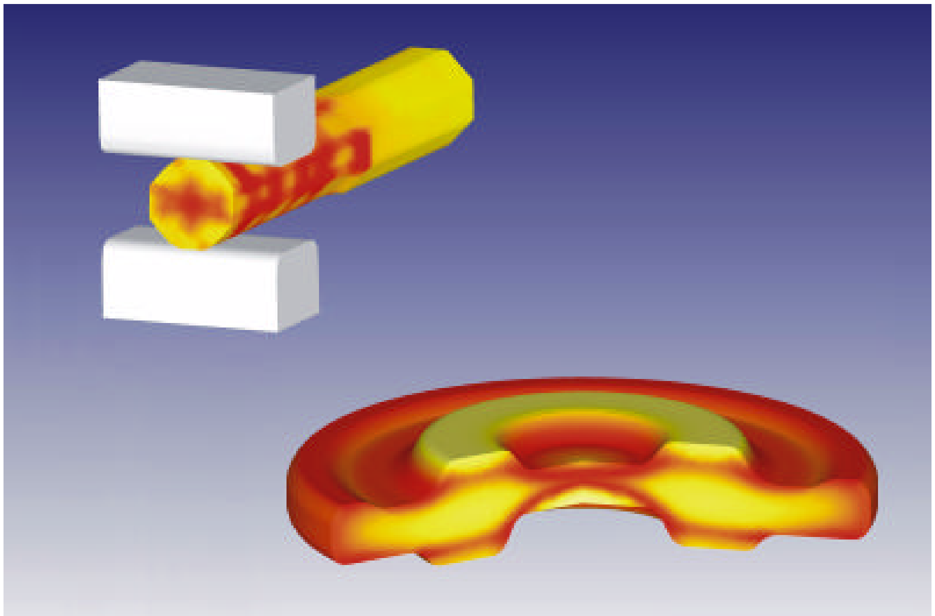
Scientific Forming Technologies Corporation
5038 Reed Road
Columbus, Ohio
43220-2514
Tel: (614) 451-8330
Fax: (614) 451-8325

www.deform.com email: sales@deform.com



Residual hoop stress in a turbine disk is shown after an oil quench and stress relieve cycle. The red areas are in tension and the green depicts compression.



*The **Microstructure Module** can predict the grain evolution during hot forging of nickel based alloys such as Waspaloy and IN718. Optimization and control of grain size is crucial to achieve a good balance of creep, strength and fatigue properties. Recrystallization kinetics and grain growth are considered in this module. Upper left: The grain size prediction during a cogging process is shown. Lower right: The grain size of a hot forged nickel based alloy disk is shown. In both cases, the red shows a finer grain and yellow a coarser grain size.*