

## Helping Educate the Next Generation!

- DANTE Solutions is excited to announce that the DANTE teaching license is now offered to educators at no cost! [Contact us today](#) to see how DANTE can enrich your course and give your students a competitive advantage.
- Charlie Li continues to teach undergraduate students at Cleveland State University in the Engineering Materials and Manufacturing Processes class. The class focuses on material properties and their modification through material processing and through manufacturing processes utilized in the production of various products and components.
- Justin Sims was invited to provide a lecture to University of Connecticut material science students enrolled in MSE 3034-Ferrous Alloys. The course, taught by Dr. Lesley Frame and offered to Juniors, Seniors, and Graduate level students discusses topics concerning the life cycle of steel alloys, from extraction to heat treatment. Justin's lecture will give students a broad overview of heat treatment simulation capabilities available in industry.
- DANTE Solutions continues to be an active member with LIFT and their many educational programs.

### Welcome to the DANTE Family:

- DANTE Solutions would like to warmly welcome Turkish Aerospace Industries (Turkey) and Changzhou Institute of Technology (China) to the DANTE family.

### Quick News:

- Jason Meyer will join Justin Sims in authoring contributions to Thermal Processing Magazine's [Metal Urgency column](#). Since 2020, Justin has been contributing bi-monthly columns to the publication, covering a wide range of topics relative to heat treatment and heat treatment simulation.
- Justin has been selected to chair the Project Selection Committee for the [Center for Heat Treating Excellence](#) (CHTE) at Worcester Polytechnic Institute in Worcester, MA. CHTE is an industry consortium focused on identifying, researching, and solving some of the biggest challenges facing the heat treatment industry today.
- Justin also presented a talk, titled "[Simulating Heat Treatment of Steel Parts](#)", at the November meeting for the Cleveland Chapter of ASM International. The talk explored the data required for heat treatment modeling, including data for diffusion, thermal, mechanical, and phase transformation models, and the importance of thermal boundary conditions during simulation.
- DANTE Solutions is proud to be working with the Cleveland Chapter of ASM International to bring our DANTE utility tools to their new [Data Ecosystem](#). The DANTE utilities will be available to help users evaluate, design, and optimize heat treatment processes. A few examples include recipe determination/optimization for gas and low pressure carburization and determining the cooling rate required to achieve a desired microstructure or hardness.
- DANTE submitted a publication for the [4th International Ingot, Casting, Rolling, Forging \(ICRF\) Conference](#) in Pittsburgh, PA on June 21—23, 2022. The publication, titled "Process Design for Induction Hardening of a Steel Work Roll using Simulation" will also be presented by Justin at the conference. We hope to see you there!



Since 1982 we have provided engineering services to the metalworking industries, and for over 30 years we have focused on thermal processing. Our range of services has expanded to include several software products, with our DANTE<sup>®</sup> software being the premier package in the world for modeling heat treatment of ferrous parts. In recognition of this, we re-branded ourselves as Dante Solutions, Inc. in January, 2014.

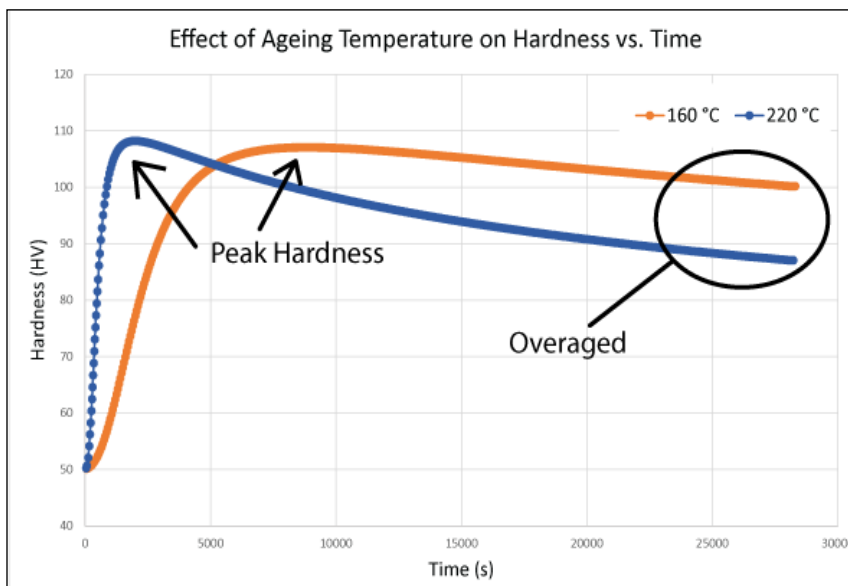
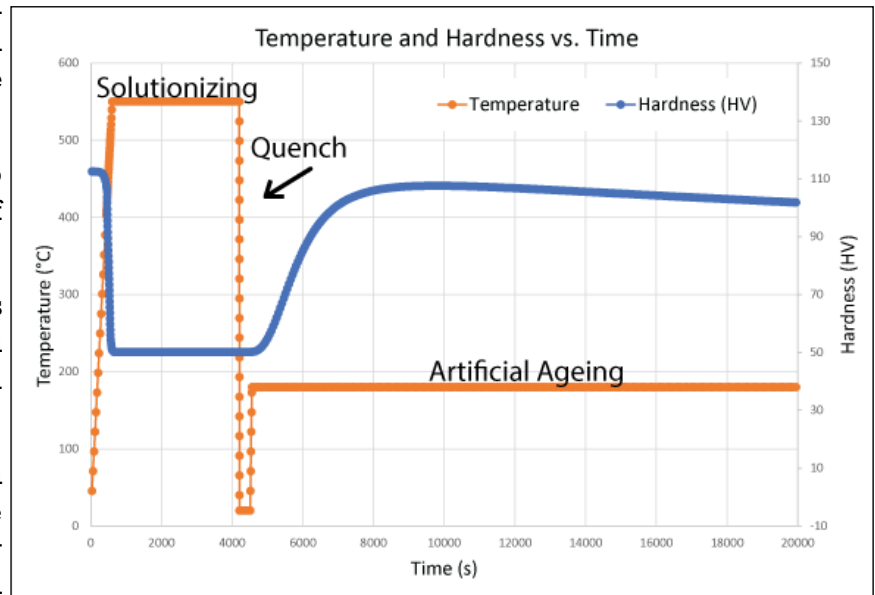
While we use computer analysis tools for most of our work, we are much more than analysts using computer software tools. Our staff includes experts in mechanical and metallurgical engineering. Let us help you improve your heat treatment and deformation processes, use new materials, and develop new products.

## Software Highlights

# DANTE Aluminum Model is Here!

DANTE Solutions has been diligently working on a precipitation hardening and coarsening (over-aging) model which is now ready for industry. The decomposition (solutionizing) and formation of precipitates over the course of a heat treatment has a significant effect on the hardness and mechanical properties of the material. As they form and grow, precipitates impart strain on the material, and in turn, generate residual stresses.

- The model allows two precipitates to be defined, capturing the behavior of each when solutionizing or ageing
- The model uses rate-based equations to predict the decomposition and ageing of precipitates, defined over a range of temperatures
- Precipitate size is accounted for, which affects the rate of precipitate decomposition during solutionizing and the final hardness and strain from the ageing process
- Spherical or oblong precipitates, and their effect on decomposition, are accounted for through the use of a shape factor
- The coarsening model predicts at what time the peak hardness will occur and how much hardness is lost due to over-aging



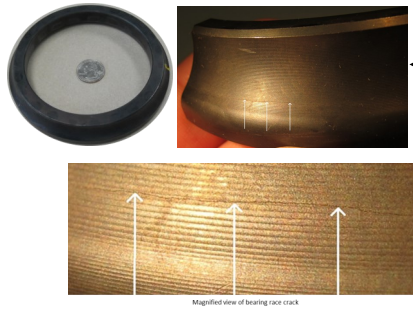
- Distortion and residual stress are predicted from the volume change of the precipitates as they form and grow or decompose and shrink during the hardening process (solutionizing & aging)
- The model comes ready to run with one standard material and parameters that can easily be tuned to your particular melt. More materials are continually being added as data is fit and validated
- The precipitation hardening model can be used for any material which uses solutionizing and aging as its main hardening mechanism, including Al, Mg, PH steels (C64, P675), Ni-based alloys, etc.

# Project Highlights

## Understanding Process Sensitivities in Press Quenching

### Background:

- 100 mm bearing ring made of AISI 52100
- 60% experienced cracking issues after Quench & Temper
- Press quench process used to control final shape during quenching

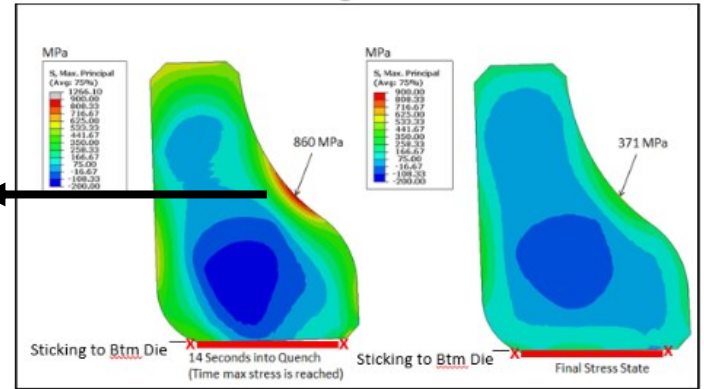


Magnified view of bearing race crack

### Virtual Design of Experiments:

- Two processing parameters were evaluated in this study, though these could have been expanded substantially
  - Friction coefficient between the bearing and the press quench tooling, as well as sticking
  - Oil flow rate through press quench unit
- The 9 case test matrix used, as well as stress results at the surface near the crack location for each case, is shown in the table below

Case	Friction Coefficient	Quench Practice	Press Load	Maximum In-Process Stress (MPa)	Final Maximum Stress (MPa)
1	0.05	Standard Press Quench	4000 lbs	642	400
2	0.05	Low Flow Press Quench	4000 lbs	400	236
3	0.2	Standard Press Quench	4000 lbs	668	403
4	0.5	Standard Press Quench	4000 lbs	691	422
5	0.05	High Flow Press Quench	4000 lbs	746	472
6	Sticking – Both Top and Bottom Dies	Standard Press Quench	N/A	882	338
7	Sticking – Top Die	Standard Press Quench	N/A	680	393
8	Sticking – Bottom Die	Standard Press Quench	N/A	860	371
9	0.05	Reduced Quench on Inside Ring Surface; Standard Quench on Outside Surface	4000 lbs	325	230



- Max in-process hoop stress shown for Case 8
- Magnitude sufficient to initiate surface cracking
- With these findings, the pulsing function was initiated on the equipment and 206 rings were processed, with half subjected to no pulsing

Load Num.	Number of Rings	Press Quench Setting	Cracked Rings After Quench	Cracked Rings After Temper
1	52	No Pulse	29	4
2	51	Pulse	0	4
3	51	No Pulse	19	11
4	52	Pulse	0	0

- From the above table, when pulsing was not used, there was ~60% failure rate
- When pulsing was used, there was ~4% failure rate
- Heat treatment simulation is a powerful tool when applied to press quench troubleshooting or parameter optimization
- Executing a design of experiments in the virtual space allows for tremendous understanding, while keeping costs to a minimum

- Max in-process hoop stress shown for Case 1, 2, and 5 (from left to right)

