

Wishing Everyone the Very Best

As the world continues to suffer through the COVID-19 pandemic, great acts of humanity and humility continue to warm our hearts everyday. The stories of individuals donating time, food, or supplies are truly wonderful. The dedication and will displayed by essential and healthcare workers that help keep us, our families and businesses, going and healthy is astounding. Each careful act we take, be it a noisy video conference or simply respecting guidelines, underlines a great deal of patience and compassion shown in support for those trying get us through this pandemic. At some point, we will get through this ordeal. And when we do, we plead that everyone remember these great acts of kindness and compassion as we transition into a post-pandemic lifestyle. Do not forget what is possible when people work together for the greater good.

Quick News:

- Dan Londrico represented DANTE at America Makes' Members Meeting & Exchange on October 13—14. Hosting a virtual table, Dan shared DANTE material and networked with a wonderful group of people. DANTE has been an America Makes member since 2013 and looks forward to a long and fruitful relationship.
- Lynn Ferguson mediated ASM International's "Modeling of Thermal Processes" education symposium on November 10th, 12th, 17th, and 19th. The symposium brought together great minds from the thermal process modeling community to give presentations and answer questions from participants. Several DANTE team members participated:
 - Charlie Li gave a presentation titled "Modeling Carburizing and Nitriding Processes for Steel Parts" on November 12th. Charlie briefly described carburizing and nitriding processes of steels. Most of the presentation focused on the modeling of these processes, including the boundary conditions and carbide formation and dissolution. Material and equipment characterization, including experimental results and data fitting, were also described.
 - Justin Sims gave a presentation titled "Simulating Quench Hardening Processes of Steel Parts" on November 19th. The talk discussed the phenomena which must be considered by the heat treatment model, thermal boundary conditions, and the mechanical and transformation kinetics models used by the DANTE software. Several case studies were also reviewed.
 - Dan Londrico gave a presentation titled "Distortion of Permanent Casting Molds" on November 19th. Dan reviewed a case study of a permanent mold casting insert, including data requirements. He showed that stress relaxation was the main contribution to the warpage of the insert over a casting campaign.
- Justin Sims discussed heat treatment modeling, including the necessary phenomena needed in a heat treatment model, boundary conditions, and the mechanical and transformation kinetics models used by the DANTE software at the 7th Thermal Treatment Processes Seminar in Brazil, organized by Grupo Aprenda, on October 8th. Several case studies were also shared with the participants.
- Charlie Li gave a talk on heat treatment modeling at the 2nd International Heat Treatment Simulation Symposium, Qingdao, China on September 25th. The talk focused on Industry 4.0 and simulation's role in the latest revolution. The use of heat treatment process data and the Material Genome Initiative were also discussed. The presentation concluded with simulation examples showing the importance of understanding the initial condition of material being heat treated for consistent processing results and accurate models.

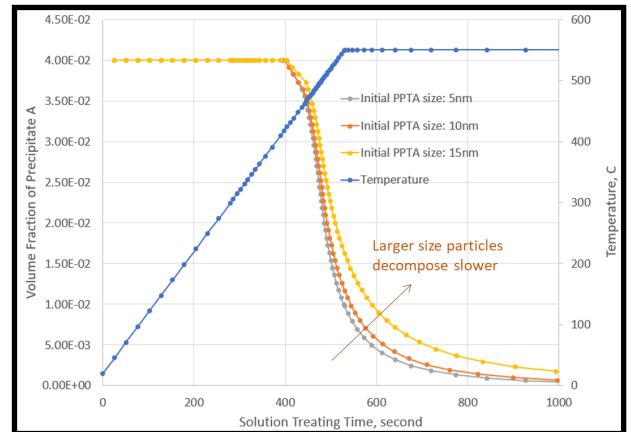
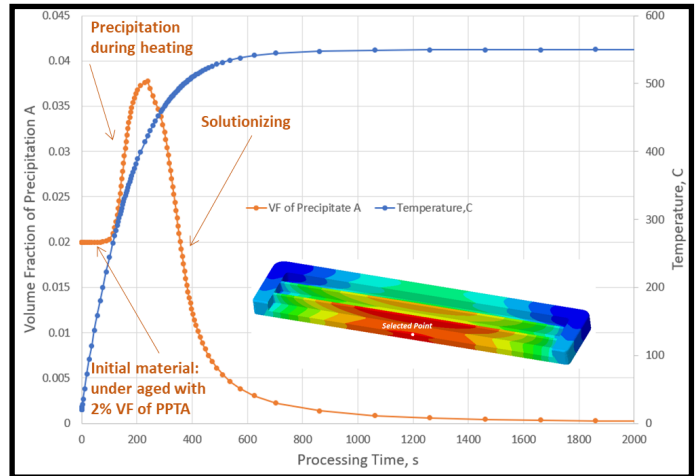
Software Highlights

AGE HARDENING MODEL NOW AVAILABLE!

DANTE Solutions, Inc. is excited to announce the availability of our all new age hardening model! This model can be utilized to predict the hardness, in-process and final stress state, precipitate formation and dissolution, and dimensional change for solutionizing and aging of aluminum alloys, nickel-based alloys, and precipitation hardening steel alloys.

The following models are included:

- **Precipitation Model**
 - Possible forming of second phases during quenching after solution treatment
 - Forming of second phases during aging
 - Location of precipitates; inside the grain or on the grain boundary
- **Precipitate Coarsening Model**
 - Effective algorithm to describe the precipitate size distribution
 - Particle sizes are time and temperature dependent
- **Recrystallization and Grain Growth Model**
 - Considering information of plastic strain from previous manufacturing process
 - Alloy content and temperature dependent
- **Multi-phase Thermal Properties Model**
 - Thermal properties are defined based on precipitate volume fractions, size distribution profile, and temperature
- **Multi-phase Mechanical Properties Model**
 - Elastic properties are defined as functions of temperature, volume fraction of phases, and size distribution profile
 - Plastic properties: Yield, hardening and recovery are affected by the alloy content, temperature, strain rate, strain, volume fraction of phases and size distribution profile
- **Material Property Prediction Model**
 - Predict yield strength, ultimate strength, ductility, hardness, etc.



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[®] 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.

For more information, contact us: support@dante-solutions.com

Project Highlights

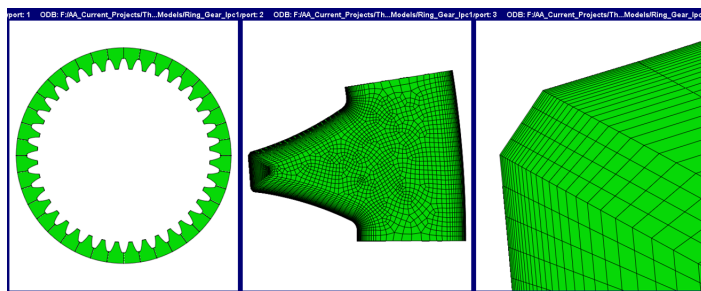
Low Pressure Carburization Process Improvement for a Ring Gear: Controlling Carbide Formation

Problem Statement and Objective:

- Large carbides were formed during low pressure carburization (LPC) of a ring gear
- DANTE was used to redesign the LPC recipe to reduce the amount and size of carbides formed

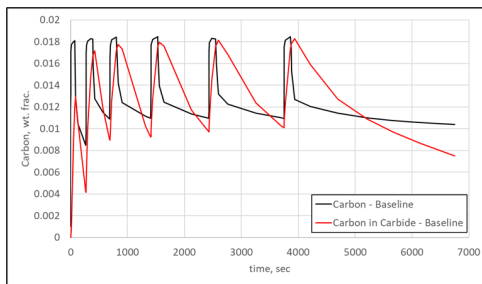
Geometry & Model Description:

- Material: Ferrum C64
- Outer Diameter: 5.5 inches
- Inner Diameter: 4.5 inches
- Height: 0.060 inches
- Number of Teeth: 40

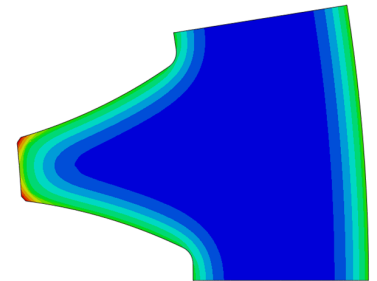
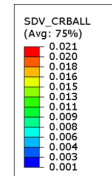


Results: Original Process (Baseline Model)

- Six boost-diffuse steps used
- Predicted carbon in the austenite matrix (Carbon) and carbon in primary carbide form (Carbon in Carbides) at the surface of the flank shown
- Carbides formed during first boost step continue to grow as the process progresses, indicated by the increasing Carbon in Carbide
- Increased carbides in the near surface can damage fatigue performance

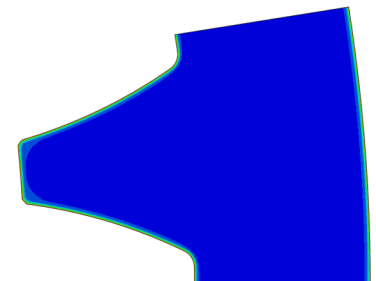
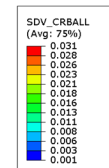
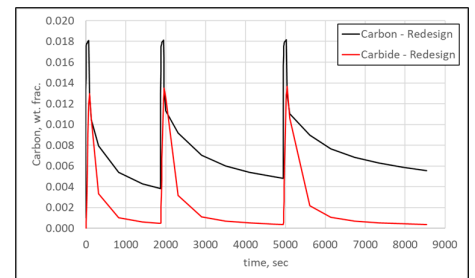


- Contour plot shows total carbon weight fraction
- Areas above 0.011 carbon contain primary carbides
- Tip contains a high amount of primary carbides



Results: Process Modification

- Three boost-diffuse steps used to reduce the total carbon entering the part surface
- Carbides nearly dissolved at the end of each diffuse step, as shown in the plot
- The contour to the right shows that some carbides exist, though the depth has been reduced to the near surface, easily removed by the final finishing operation



Conclusion

- DANTE used to successfully predict the results of an LPC process that was resulting in poor part performance during rolling contact fatigue
 - Large primary carbides exist at a depth of 0.25 mm (0.010 inch)
 - Carbides do not have time to dissolve during the boost steps
- DANTE used to successfully redesign the boost-diffuse schedule to improve rolling contact fatigue performance by reducing the amount and depth of carbides formed during the LPC process

One can view this, and many more aerospace case studies online at: <https://dante-solutions.com/aerospace>