

Current challenges and future opportunities within heat treatment of steel

Thomas L. Christiansen

Center for Heat Treating Excellence (CHTE), Worcester Polytechnic Institute, Massachusetts

Heat treatment of steel has been around for ages and has gone through significant developments over the years, although the basic concepts largely remain the same. This presentation will address selected topics within heat treatment, touching upon historical perspectives and focusing on current challenges and future opportunities. The topics selected for this presentation include:

Nitrogen steels

When we consider *good-old* “steels”, carbon is the key element that brings about the special properties (when heat treated). We are currently talking about “decarbonization of steel” with respect to environmental sustainability. Could we take this concept literally and substitute carbon with nitrogen? Assorted examples of the important use of nitrogen as an *alternative* to carbon will be addressed and new opportunities within heat treatment as well as thermochemical surface engineering will be discussed.

Additively manufactured “Damascus” steel

“Damascus” steel is the name for the ancient blades forged in Damascus from layered Wootz steel imported from India. These blades were renowned for their superior properties compared to European blades. It will be shown that it is possible to replicate the “Damascus” (or Wootz!) structure by using metal additive manufacturing and heat treatment. This entails such concepts as quench & partitioning and sub-zero treatment.

Quenching

Quenching is an inherent part of heat treating and is extremely important for the properties and performance of the treated components. The way quenching is performed dictates the stress profile in the part and is highly linked to dimensional stability. High pressure gas quenching, which is becoming increasingly popular, and intensive quenching (IQ) will be discussed. IQ is perhaps ripe for a “renaissance” as this method potentially can compete with carburizing for developing compressive residual surface stresses.



Biography:

Thomas L. Christiansen joined Worcester Polytechnic Institute in July 2023 as new Director of the Center for Heat Treating Excellence (CHTE) and Professor in Mechanical and Materials Engineering. He has close to 25 years of experience in thermochemical surface engineering and heat treatment of metallic materials. He was previously affiliated with The Technical University of Denmark (DTU) in Europe. He has been deeply involved in innovation activities and is the co-founder of two heat treatment companies. He has (co-)authored more than 165 articles/book chapters and is the co-inventor of 18 patents. Thomas has a keen focus on the synergistic interplay between science and technology and how this best can be exploited to provide solutions to challenges in industry.