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Characterization of nanoscale precipitates in a new 2GPa strength steel using small angle x-ray scattering

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Steels are used extensively in the manufacture of automobiles. They may not sound like advanced materials to those not involved in their development – after all they have been available for centuries. However, if we consider a typical modern automobile, none of the steels found in the structure existed 10 years ago. These are engineering alloys that are being intensively developed and improved, and more so than any other alloy class.

This presentation discusses a new class of steel with strengths approaching 2GPa that was developed for applications in the automotive industry. The alloy design process included the coupling of computational thermodynamics with a Genetic Algorithm for compositional optimization. The dominant contribution to these high strengths is a nanoscale distribution of particles within the material and a quantitative understanding of their size, shape and volume fraction is a key requirement for rationalizing the observed properties.

The particle distribution was characterized at the Australian Synchrotron using small angle x-ray scattering (SAXS) in both ex-situ samples and during in-situ thermal treatments to monitor the earliest stages of particle nucleation and growth. Combined with 3D measurements of particle compositions using atom probe tomography (APT), it was possible to extract bulk quantitative measures of the particle volume fractions and hence calculate representative number densities of particles. These nanoscale particles have number densities comparable to the highest densities so far observed in engineering alloys. The information gained from these SAXS and APT experiments helps to verify and improve the computational alloy design process.

Keywords or phrases (comma separated)

SAXS, steel, nanoscale precipitation

Summary

Primary author(s) : Prof. HUTCHINSON, Christopher (Monash University)

Co-author(s) : Dr STYLES, Mark (CSIRO); Dr MARCEAU, Ross (Deakin University); Ms SUN, Wenwen (Monash University)

Presenter(s) : Prof. HUTCHINSON, Christopher (Monash University)

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