Characterization of Aluminum Alloys for Cylinder Heads

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Abstract

Turbo-charged engines typically have higher efficiency than naturally-aspirated engines. That higher efficiency though comes at the cost of the engine running at higher temperatures and pressures, leading to strategies to improve the engine cooling and also assuring engine's structural durability at higher temperatures. New aluminum alloys are needed for improved performance at these new extremes. In this regard, Al-Cu, Al-Si-Cu and Al-Si alloys were investigated with respect phase content, micro- and nanostructure using laboratory and synchrotron radiation, metallography and TEM. As-aged and preconditioned (300°C for 200 hrs) states were considered to study the thermal stability of the nanostructure (viz., coarsening and phase transformation of strengthening precipitates). Atom probe results were coupled with thermodynamic modelling to understand the nature of the strengthening intermetallic phases. New alloys will result in different residual stress distributions after casting, which could impact castability and durability in service. The residual stresses were determined at key locations within cylinder heads cast from a baseline alloy using neutron diffraction in the air and water quenched conditions. This study is part of a larger study for the design of higher temperature capable cast aluminum alloys.

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