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Session
E-4: Casting and Additive Manufacturing
10:20 AM 06/22/2023 Thursday
Lecture
#73
EL5 - Main Room

Evaluation of the strain field induced by iron inclusions in a cast Al-alloy using correlated microscopy

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Secondary aluminum alloys have big advantages with respect to their ecological footprint. However, thes inevitable contain a certain amount of iron. Various intermetallic compounds are found in the (Fe,Al+X)-system. The most prominent one is the so-called beta-phase Al5SiFe forming brittle needle-like inclusions. The available experimental database show that these inclusions greatly influence the material strength under quasistatic loading, but have very little impact on the fatigue strength. A model alloy was designed which contained very large grains and beta inclusions, but no other microstructural features expect the unavoidable Si-precipitates. Small specimens were loaded in a micro-tensile device, and the strain field on the specimen surface was monitored using high-resolution digital image correlation at successive loading steps. It was found that the major strain concentrations occurred on the inclusion-matrix interface for moderate load levels, whereas the material in the vicinity of the inclusion tip remained inactive below macroscopic yield. Consequently, cracks were initiated by decohesion of the beta inclusions from the matrix. Final failure was caused by linking of these decohesion cracks. Once a crack was initiated, it propagated along twin boundaries in the iron inclusion. Hence, the observed brittle nature of the beta iron inclusions is related to a two-stage fracture process induced by the strain mismatch of the Al-matrix and the iron-rich intermetallic inclusions.