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C05: Small Scale and In Situ Mechanical Testing

In-situ study of a crack initiation mechanism in the aluminum alloy 7475-T7351

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A study of an effect of the surface topography and material inclusions on mechanical properties of the aluminum alloy 7475-T7351 that was carried out in a scanning electron microscope (SEM) equipped with a combined in-situ heating and tensile fixture. The studied aluminum alloy 7475-T7351 prepared with so-called “controlled toughness” would provide a great combination of a high tensile strength, good fracture toughness and a high resistance to the fatigue crack propagation. An optimal resistance to the stress corrosion cracking due to a special heat treatment of the alloy had been expected. The characterization of structure (texture and grain size) and electron backscattered diffraction mapping (EBSD) of selected elements were used. The energy dispersive X-ray analyses (EDX) of the surface (and locally in the cross-sections that were produced by focus ion beam technique (FIB)) were used for an identification of inclusions. However, in this research a large disperses of the fatigue results was observed. The surface topographies made under different cutting conditions of down milling, have not proved to have a decisive impact on the fatigue. A very evident decohesion between the alumina matrix and brittle inclusions have been observed. Tensile loading of specimens confirmed that crack nucleation started at the brittle particles and the material was locally fractured before reaching the tensile strength limit. According to the morphology, size and distribution of the phases the complex Al-Fe-Cu-Cr-(Si, Ni) intermetallic inclusions have been identified to have a crucial effect on the tensile mechanical properties, especially the fracture elongation, and the fatigue properties also.

A novel approach of the multi-site in-situ deformation process monitoring has been used with the advanced application of NewTec tensile stage and TESCAN SEM control and automation.

