

Materials Science and Engineering Master's Defense

Effect of Foreign Object Damage on Fatigue of Inconel 718 at elevated temperature (1050 C)

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abstract

The use of solar energy to produce power has increased substantially in the past few decades. In an attempt to provide uninterrupted solar power, production plants may find themselves having to operate the systems at temperatures higher than the operational capacity of the materials used in many of their components, which affects the microstructural and mechanical properties of those material. Failures in components that have been exposed to these excessive temperatures have been observed during operations in the turbine used by AORA Solar Ltd. A particular component of interest was made of a material similar to the Ni-based superalloy Inconel 718 (IN 718), which was observed to have damage that is believed to have been initiated by Foreign Object Damage (FOD) and worsened by the high temperatures in the turbine. The potential links among the observed failure, FOD and the high temperatures of operation are investigated in this study.

IN718 is a precipitation hardened nickel superalloy with resistance to oxidation and ability to withstand high stresses over a wide range of temperatures. Several studies have been conducted to understand IN 718 tensile and fatigue properties at elevated temperatures (600- 950°C). However, this study focuses on understanding the behavior of IN718 with FOD induced by a stream of 50 μm Alumina particles at a velocity of 200 m/s. under high cycle fatigue at an elevated temperature of 1050 °C. Tensile tests were conducted for both as-received and heat treated (1050 °C in air for 8hrs) samples at room and high temperature. Fatigue tests were performed at heat treated samples at 1050 °C for samples with and without ablation. The test conditions were as similar as possible to the conditions in the AORA turbine. The results of the study provide an insight into tensile properties, fatigue properties and FOD. The results indicated a reduction in fatigue life for the samples with ablation damage, where crack nucleation occurred either at the edge or inside the ablation region and multisite cracking was observed under far field stresses that were the same than for pristine samples, which showed single cracks. Fracture surfaces indicate intergranular fracture, with the presence of secondary cracks and a lack of typical fatigue features, e.g., beach marks which was attributed to environmental effects and creep.