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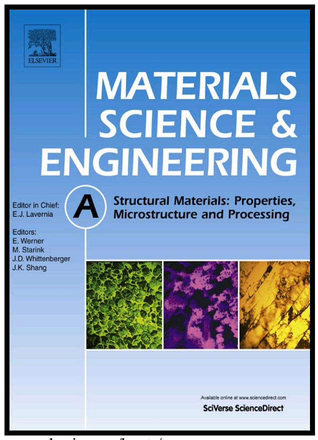

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Effect of Microstructure on Tensile Properties of Electrospark Deposition Repaired Ni-superalloy

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Abstract

Cavities introduced to Inconel 718 tensile specimens were repaired with the use of electrospark deposition (ESD) and tensile properties of repaired specimens were investigated. Reduced energy input during ESD resulted in a larger number of splat boundaries and greater yield strength recovery during tensile testing. Analysis of the fracture surface showed a trans-splat and inter-splat crack propagation pathway, with splat boundaries exhibiting lower fracture toughness than material within the splats. Changes in crack propagation direction were attributed to grain growth across splat boundaries and brittle secondary phases forming within splats during ESD.

Keywords: Electrospark deposition; Nickel superalloy; Tensile properties; Fracture behaviour

1. Introduction

The use of electrospark deposition (ESD) for the repair of damaged components is often proposed and investigated in literature [1,2]. Most applications focus on expensive components for which no other cost-effective or high-quality process exists. Oftentimes, the detrimental effects of heat affected zone formation, residual stresses and welding induced distortion limits the type of repair process that can be used. These effects can be mitigated through ESD repair techniques [3]. For this reason, aerospace and energy industries are common targets for the application of ESD, in which many high performance and high cost materials are subjected to extreme operating conditions. These applications include the repair of gas turbine engine blades suffering from issues such as chipped or damaged coatings, and dimensional restoration of out-of-tolerance manufactured parts [3]. This avoids completely replacing or scrapping the affected components, providing an economic incentive for the implementation of an ESD repair process.

The ESD micro-welding process makes use of a consumable electrode deposited onto a conductive substrate through a series of short-duration electrical sparks. Material transfer results in splats that rapidly solidify and undergo metallurgical bonding with the substrate. The short pulse duration often results in minimal heat affected