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Fatigue Properties of Additively-Manufactured Maraging Steel Deposited on Conventionally-Melted Plate

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Abstract

Additive manufacturing (AM) of metals is increasingly attracting attentions as a new fabrication method of engineering components in automotive, aerospace and medical fields, because AM is suitable for the near-net-shape manufacturing and for small quantity, large variety production. Furthermore, AM could be used for the repairment of engineering dies. In the repairment process, base powder will be additively deposited on the conventionally-melted (CMed) materials. To ensure the reliability of repaired engineering die, the understanding of fatigue properties is important. In the present study, maraging steel power was additively deposited on the CMed maraging steel base plate by powder bed fusion (PBF) type selective laser melting (SLM), to fabricate hybrid structure of additively-manufactured (AMed) and CMed maraging steels. It was found that tensile residual stress was induced in the AMed layer on the CMed substrate due to the deposition of melted powder on the un-melted substrate. Subsequently, tensile fatigue tests were conducted using specimens having hybrid structure. The fatigue test results showed that the fatigue strengths of AMed specimens were lower than those of CMed ones. That is because fatigue fracture basically occurred in the AMed layer with defects which were formed during SLM process, and the defects could be preferential fatigue crack initiation sites. Furthermore, it was confirmed that the transition of fatigue crack initiation mechanism occurred depending on the applied stress levels during fatigue tests. At higher stress levels, fatigue crack tended to initiate irrelevant to the defects, while fatigue crack initiated at the defects at lower stress levels. It was attributed to the residual stress relaxation at higher stress levels.

Keywords: Fatigue, Additive manufacturing, Selective laser melting, Maraging steel