FATIGUE CRACK GROWTH PREDICTION USING S-VERSION FINITE ELEMENT METHOD FOR ALSI10MG: AN ADDITIVE MANUFACTURING MATERIAL

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Abstract:
The usage of direct metal laser sintering (DMLS) process in additive manufacturing (AM) for aluminium alloys is a promising method due to the potential, benefiting manufacturing industries such as aerospace and automotive sectors. However, the current research on this method is limited to establish the integrity of aluminium alloy produced by DMLS for industrial standard. Therefore, further studies are required to gain more information about the microstructural, mechanical properties and fatigue crack growth behaviour of AlSi10Mg material produced by DMLS. The purpose of this study is to investigate the material characteristics, microstructure and fatigue crack growth behaviour of AlSi10Mg material manufactured using DMLS method. Fatigue crack growth behaviour is performed using the Sversion Finite Element Method (FEM). The S-version FEM is modeled using the global-local overlay technique that consists of two separate meshes for global and local. The behavior of the fatigue crack growth is characterized by using the association of energy release rate and stress intensity factors. Corresponding to the linear elastic fracture mechanics concept, the stress intensity factor is calculated using the virtual crack closure-integral method (VCCM). The material is also subjected to solution heat treatment (SHT) to T6 condition. The material properties, microstructure and fatigue behaviour are compared between heat-treated and as-built specimens. From the tensile test, the T6 specimen is more ductile with significant increments from 4.3% for as-built to 14.7% for T6. The maximum stress for the as-built specimen is recorded at 280.4 MPa whiles the T6 specimen is at 310.2 MPa. This study provides insight into the material haracteristic such as microstructure and mechanical properties. Hence, further investigation is needed to improve the integrity of AM for especially material strength and material fatigue behaviour for AM material manufactured using DMLS method.nanoparticles in the presence of oil were longer rather than the distance transported without oil.

Keywords : Additive Manufacturing; 3-D Rapid Prototyping; Direct Metal Laser Sintering; Aluminum Silicon Magnesium Alloy

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