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Mechanical Properties and Effect of Residual Stress in Titanium Alloy Built by Laser Additive Manufacturing Process

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Additive manufactured process can efficiently reduce the machining time and the cost of material of aircraft structures, yet the scattered property data limits its application in aerospace industry. This paper presents the static and fatigue mechanical properties of titanium alloy built by Selective Laser manufacturing (SLM) in three status: as-built, machined and Hot Isostatic Pressing. The corresponding damage evolution law and failure models can be obtained in this study. Residual stress induced by process was measured by neutron diffraction and X ratio methods. In addition, the static strength, detailed fatigue rating and crack growth rate were discussed with respect of process parameters; the static and fatigue properties of short beam fabricated by laser forming repair were also investigated by four-point bending test. Key conclusions are received: a) HIP and machining processes can produce the compressive residual stress, which improve the static and fatigue properties of SLM titanium material, and lower its crack growth speed; the specimens with laser forming repair process will have the similar properties to the forged ones.