LOW-CYCLE FATIGUE TESTING SETUP FOR ADDITIVELY MANUFACTURED 316L STAINLESS STEEL MATERIAL

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Abstract

During exploitation metallic components are subject to dynamic loading, thus a better understanding of material behavior in such conditions is mandatory. Loading conditions in such cases include creep and fatigue, with more failure cases in the fatigue regime. Fatigue tests can be performed in Low- and High-cycle regimes, depending on chosen control parameters. The High-cycle regime controls the amount of stress, and opposite to it Low-cycle regime is performed in a strain-control state. The subject of this research is Low-cycle regime testing, i.e., testing in control of strain amplitude. Regular dynamic machines for this type of test require the definition of cycle frequency, amplitude level, and specimen geometry to assess the dynamic properties of the material. The material of interest is an austenitic stainless-steel material 316L, which is a low-carbon version of 316 steel. Due to high corrosion resistance and possible high-temperature applications, targeted material can be used in the petrochemical, marine, biomedical industry, etc. High-temperature applications may include fatigue tests at elevated temperatures, thus fatigue machine must be equipped with a heating chamber. For fatigue testing, specimen surfaces have to be smooth and clean, to prevent crack initiation from surface irregularities. Because of the nature of AM process, i.e., surface irregularities are expected, each specimen must be polished and etched, and afterward treated surfaces must be inspected on an optical and SEM microscope. Specimens that pass the inspection can be fatigue tested. After testing, results from the machine must be data processed in order to obtain cyclic stress-strain curves (hysteresis loop), cyclic hardening/softening curve, and Manson-Coffin representation.

Keywords

316L stainless steel, fatigue testing, metallic components, AM process

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