Synchrotron X-ray tomography based defect tolerance of additively manufactured Ti-6Al-4V

Z. Song[1], †S.C. Wu[1], and J. Zhang[2]

[1]State Key Lab. of Traction Power, Southwest Jiaotong University, Chengdu 610031, PR China
[2]AVIC Manufacturing Technology Institute, Beijing 100024

Presenting author: SZsongzhe@163.com
†Corresponding author: wusc@swjtu.edu.cn

Abstract

Additive manufacturing or 3D Printing has currently become one of the important molding techniques into specially used structures. Nevertheless, intrinsic defects such as pores and shrinkages physically determine the fatigue resistance of additively manufactured components. As an advanced dimension calibration tool, synchrotron radiation X-ray microtomography (SR-μCT) has the advantages of real-time observation and in situ imaging for a bulk material, whilst the internal microstructure and defect evolution can be characteristic of "visualization". By tracking the damaging process of critical defects under monotonic and reversed loads for small-sized specimens, fatigue damage mechanism can be clearly extracted for the determinant of the defect tolerance of additively manufactured titanium alloys. High cycle fatigue and fractography of standard specimens are also conducted to tentatively correlate with in situ SR-μCT based defect behaviors in terms of modified KT diagram. Moreover, micromechanics damage simulation is introduced to identify the evolution of critical defects. It is thus expected that the defect tolerance based performance assessment can be established for predicting the residual life and nondestructive inspection interval of additively manufactured structures.

Keywords: Defect tolerance design; Fatigue crack initiation and propagation; Synchrotron radiation X-ray microtomography; Residual life; Additive manufacturing.