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Fatigue life of 316L steel sinters of varying porosity under conditions of uniaxial periodically variable loading at a fixed stress amplitude

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Abstract: This paper presents new test results of the fatigue life of porous 316L steel sinters with porosities of 41%, 33% and 26%, obtained in the process of powder metallurgy. Tests were performed under conditions of uniaxial, periodically variable loading at a fixed amplitude and zero mean stress value. Variability analysis was conducted over the course of periodic loading: of maximum and minimum strain values in loading cycle, elastic modulus values and of hysteresis loop shape. Microscopic examinations of fractures in samples obtained during fatigue tests were also performed, with indication of the mechanism of material destruction. A stress-based damage accumulation model under uniaxial (tension – compression), periodically variable loading conditions is proposed. The increment of the isotropic material damage state variable was made dependent on the value and increment of stresses. A critical value of the damage state variable or critical value of stresses dependent on this variable was applied in fatigue crack initiation criteria. Numerical dependencies were positively verified on the basis of the results of original fatigue tests.

Keywords: porous sinters, 316L steel, fatigue life, damage accumulation model, fatigue loads

1. Introduction

Porous metal sinters are a group of materials that have found applications in many branches of industry, mainly due to their good absorptive and damping properties, as well as light weight. Despite the fact that they are fabricated from powders of solid material with specific properties, they are characterized by mechanical, physical, thermal, electric and acoustic properties that differ from those of solid materials. This is affected by, among other things, relative density, type and distribution of pores [1-3]. This is also why they are eagerly used in the aviation and motorization industries [4,5]. Porous sinters have also gained significant popularity as biomaterials in biomedical engineering, replacing solid materials