A Metallographic Examination into Fatigue Crack Initiation and Growth in Ferrous PM Materials

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Abstract

Porous materials behave differently under fatigue loading compared with pore-free materials. The internal free surfaces, i.e., pore edges, often act as crack initiation sites and cracks usually grow from one pore to a near-neighbor pore. Depending on the type of fatigue loading, this may occur simultaneously at multiple sites inside the part until the critical crack length is reached and fast fracture takes place. The phenomenon of crack initiation and growth will be explored using axial fatigue specimens tested to failure and where the load was removed prior to failure. The samples are pearlitic, nearly eutectoid, and in the as-sintered condition, having differences in both chemical composition and pearlite spacing. Furthermore, an additive was utilized to create larger pores in the sintered samples and allow the effect of pore size to be studied as it related to cyclic loading. Both light optical and scanning electron microscopy were used to examine the pore size distributions, interlamellar pearlite spacings, details on fracture surfaces, fracture surface profiles, and cross-sections through stressed regions in failed and pre-failure specimens.

Introduction

The features observed in a metallographic examination of powder metallurgy (PM) materials reveal several important characteristics that are unique to porous products. Because of these peculiarities, PM materials behave differently when subjected to various types of stress. The most obvious is the pore structure, which is a by-product of the press and sinter process. This structure is often interconnected and provides a large amount of internal surface area that is important in surface-sensitive applications, such as those experienced by a part subjected to cyclic loading.[1-3] This inherent pore structure acts as resident defects and has a profound effect on material behavior considering fatigue cracks usually initiate at