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# A METALLOGRAPHIC EXAMINATION INTO FATIGUE-CRACK INITIATION AND GROWTH IN FERROUS PM MATERIALS

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*Porous materials behave differently under fatigue loading compared with pore-free materials due to their internal free surfaces, which often act as crack-initiation sites. Depending on the type of fatigue loading, crack initiation may occur simultaneously at multiple sites inside the part until the critical crack length is reached and fast fracture takes place. Crack initiation and growth will be explored using tested axial-fatigue specimens in the failed and pre-failure conditions. The samples are pearlitic 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 (LOM) and scanning electron microscopy (SEM) were used to examine the pore-size distributions, interlamellar pearlite spacings, fracture-surface details, 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 provides a large amount of internal surface area. This is important in surface-sensitive applications such as those experienced by a part subjected to cyclic loading.[1–3] The inherent pore structure acts as resident defects and has a profound effect on material behavior considering fatigue cracks usually initiate at surface regions. In addition, the large pores and their frequently irregular shapes are often among the most important features within the microstructure regarding dynamic performance of a material. The large pores are most likely the largest defects in the material volume and their angular shapes often act as stress raisers that can promote crack initiation and growth.[4–9]

With crack initiation being highly surface related and PM materials having a large amount of free surfaces, multiple cracks can start and grow simultaneously. As individual cracks grow, they proceed to link neighboring pores,[2,10,11] enlarging the defect sizes through the combination of the crack lengths and the joined pore diameters. The load-bearing cross section of the matrix progressively lessens until a sufficient number of individual cracks and pores join and the final fracture occurs. If many cracks are formed through the material volume, the final fracture surface is often more irregular in appearance and shows a more tortuous profile. In the case where fewer cracks initiate, crack growth and final fracture occur almost simultaneously, resulting in a flatter, less irregular profile.

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