ROTATING-BENDING FATIGUE OF PRE-ALLOYED AND HYBRID P/M STEELS

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The effect of microstructural inhomogeneities on the rotating-bending-fatigue response of a pre-alloyed (FL-4405) and two hybrid (FLC2-4405 and FLN2-4405) steels was evaluated. Different microstructures at a nominal density of 7.4 g/cm³ were developed by conventional sintering, high-temperature sintering, quenching and tempering, and sinter hardening followed by tempering. In previous studies on these steels, tensile and impact properties, hardenability, fatigue-crack-growth rates, pore characteristics and residual-stress distributions were quantified. For each steel, the highest fatigue limit but the lowest fatigue ratio is obtained in the quenched + tempered condition. Sinter hardening of the steels containing copper and nickel increases the fatigue limit relative to the as-sintered condition. High-temperature sintering reduces the fatigue limit relative to conventional sintering. The fatigue ratio is a function of microstructure and is lowest in the three steels in the quenched + tempered condition. The inferior fatigue behavior of the copper-containing steel is attributed to the large pores resulting from the coarse copper powder.

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INTRODUCTION

Fatigue is a complex phenomenon influenced by numerous factors, as illustrated in Figure 1. For powder metallurgy (P/M) steels, pores, microstructure, surface finish, residual stresses and external notches are of primary importance.[1–21] The shape and distribution of the pores may be altered by the powder characteristics, by the processing route (for example, the powder-size distribution, alloying and lubricant additives, compaction pressure) and by the propensity for the pores to act as crack precursors which can be reduced.[15, 22–28] The microstructures of P/M steels depend on the alloying mode and the processing conditions.

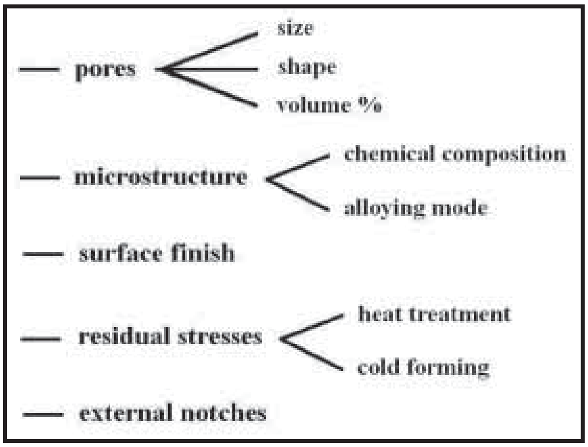

Figure 1. Factors affecting the fatigue response of P/M steels

There are four major alloying modes used for formulating P/M steels and these establish a classification for the steels: admixed, partially alloyed, pre-alloyed, and hybrid.[29] The resulting microstructures may be homogeneous or heterogeneous with respect to chemical composition and to the constituents in the P/M steel.

The effect of homogeneity/heterogeneity on the fatigue properties of P/M steels reflects significant differences of opinion. Several investigators[30–35] observe that the constituents in het-

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