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Effect of Alloying on the Microstructure and Fatigue Behavior of Fe-Ni-Cu-Mo P/M Steels

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The effect of alloying mode and porosity on the axial tension-tension fatigue behavior of a P/M steel of nominal composition Fe-4w/o Ni-1.5w/o Cu-0.5w/o Mo-0.5w/o C has been evaluated. Alloying modes utilized were elemental powder mixing, partial alloying(distaloy) and prealloying by water atomization; in each case the carbon was introduced as graphite prior to sintering. Powder compacts were sintered(1120^{0}C/30 min.) in 75v/o H_2/25v/o N_2 to densities in the range 6.77-7.2 g/cm^3. The dependence of fatigue limit response on alloying mode and porosity was interpreted in terms of the constituent phases and the pore and fracture morphologies associated with the three alloying modes.

For the same nominal composition, the three alloying modes resulted in different sintered microstructures. In the elemental mix alloy and the distaloy, the major constituent was coarse and fine pearlite, with regions of Ni-rich ferrite, Ni-rich martensite and Ni-rich areas. In contrast, the prealloy consisted primarily of martensite by with some Ni-rich areas.

From an examination of the fracture surfaces following fatigue testing it was concluded that essentially all of the fracture surfaces exhibited dimpled rupture, characteristic of tensile overload. Thus, the extent of growth of any fatigue cracks prior to overload was small.

The stress amplitude for the three alloying modes at 2x10^6 was used for the comparison of fatigue strengths. For load cycles <3x10^5, the prealloy exhibited optimum fatigue response followed by the distaloy and elemental mix alloy, respectively. At load cycles >2x10^6, similar fatigue limits were exhibited by the three alloys.

It was concluded that fatigue cracks propagate primarily through pores, rather than through the constituent phases of the microstructure. A decrease in pore size improved the S-N behavior of the sintered steel.