A COMPARISON OF THE FATIGUE PERFORMANCES OF CAST WROUGHT AND HIP P/M COBALT-CHROMIUM PROSTHETIC ALLOYS

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I. Introduction

Lifetime to failure under cyclic loading is of primary concern in the prosthetic device replacement for the human hip. It is well known that wrought alloys exhibit better fatigue performance than their cast counterparts of identical or similar composition.[1,2]

There are several reasons for the superiority of wrought alloys. First, castings generally exhibit much larger grain size than forgings. Typically 500-1000μm for cast Co-Cr alloys and 50-300μm for wrought Co-Cr alloys. Secondly, forgings exhibit much less macro and micro chemical segregation, less micro-porosity and finer non-metallic inclusions and precipitates than do castings. Finally, forgings often retain some residual warm or cold work which increases yield strength. Fatigue cracks initiate in Co-Cr-Mo-C alloys such as ASTM F-75 composition (see Table I) along [111] planes. This is a result of the peculiar deformation mechanisims operative in Co-Cr-Mo-C alloys, which have been studied in detail.[3] The F-75 alloy deforms by intense concentration of deformation in stacking faults parallel to the FCC [111] planes. This highly localized deformation causes a pronounced region of stage I crystallographic cracking including crack initiation and early propogation stages,[1].

Because the resulting initial "microcracks" are longer, low cycle fatigue cracks initiation is generally considered to be easier in large grained planar slip alloys than in fine grained alloys,[4]. Furthermore, planar slip alloys exhibit marked grain size dependence of flow