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MITIGATION OF FRETTING FATIGUE FAILURES IN TI-6AL-4V FEMORAL HIP STEMS USING LOW PLASTICITY BURNISHING (LPB)

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High cycle fatigue (HCF) strength and resistance to fretting damage can be improved by the use of mechanical surface treatments to introduce beneficial residual compression. Low plasticity burnishing (LPB) is a surface treatment that can be used to produce a deep layer of compression with superior surface finish. Extensive fatigue testing, performed on numerous metal alloys in simulated environmental conditions, demonstrates that LPB significantly improves fatigue strength of highly stressed components. LPB is a flexible process, capable of being implemented on a wide variety of CNC machine tools.

A compressive residual stress field was designed and introduced via the LPB process for the modular neck taper junction of a Ti-6Al-4V total hip prosthesis (THP). LPB produced a compressive residual stress field with an improved surface finish, which enhanced component fatigue strength and resistance to fretting damage. X-ray diffraction (XRD) residual stress measurements made on LPB processed neck tapers are shown. High cycle fatigue (HCF) results obtained on LPB-processed hip stems are shown along with baseline data for unprocessed hip stems. HCF tests demonstrate complete elimination of fretting fatigue failures in the LPB processed area of the taper junction and a substantial increase in overall fatigue strength