Low Plasticity Burnishing (LPB) Technical Monograph

Introduction

As the population continues to age and more and more patients are becoming candidates for total joint replacement, it is imperative that orthopaedic companies meet the increasing demands of this patient population. As new technology continues to emerge related to the materials and methods used to manufacture orthopaedic implants, the application of these technologies is essential to provide state-of-the-art implants to the orthopaedic marketplace.

One example of a groundbreaking new technology that has emerged in the orthopaedic industry over the past five years is in the area of surface treatments to metal parts at junction areas. There are many different processes to treat the taper junction area to reduce the incidence of wear, fretting and fracture of the metal. One example of this new technology is Low Plasticity Burnishing, or LPB.

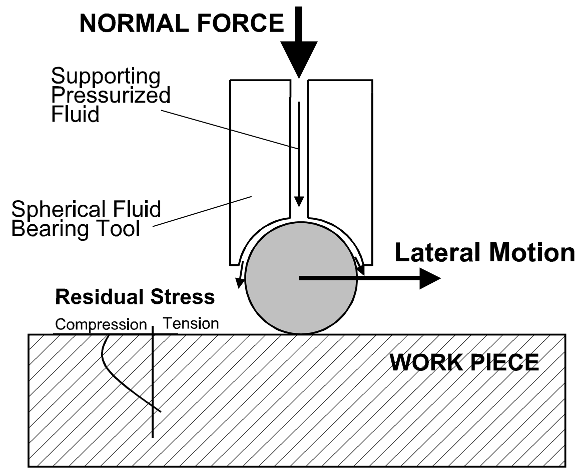

Figure 1.

What is LPB?

LPB is a patented process created by Lambda Technologies of Cincinnati, Ohio, and was originally utilized to treat turbine blades on aircraft engines. The turbine blades undergo severe stresses while spinning, somewhat similar to the cyclical stresses a prosthesis undergoes once implanted. The LPB process imparts residual compressive stresses to the surfaces of these metal parts, thus dramatically enhancing the fatigue strength. The stress levels are optimized for a particular part by controlling the normal force applied to the spherical tool, which rolls over the part surface (Figure 1). These residual compressive stresses in the part surface counteract the tensile stresses applied during loading. Fatigue failure occurs primarily when cracks initiate on the surface of a part due to application of tensile stresses, and then propagate until complete fracture takes place. However, if the surface of the part is in compression, cracks are less likely to initiate and thus the fatigue strength is increased. Furthermore, parts treated with LPB have a polished appearance, which reduces the incidence of fretting and surface defects that can lead to crack initiation.

LPB is applied to a part by rolling the spherical tool across the entire surface in adjacent passes. On the AcuMatch® M-Series, which is the first Exactech product to utilize this new technology, LPB is applied in a helical pattern around the distal neck taper. This pattern creates a compressive stress field on the entire taper surface. The pressurized fluid shown in Figure 1 is the same approved machine tool coolant used to manufacture the neck, and acts as a bearing to support the spherical tool. One important feature of the LPB application method is that it is highly controllable and can be validated, which ensures that the process can be successfully applied to every part.

Other Methods of Surface Treatment

There are many other methods of surface treatment in use today in the orthopaedic industry. Roller Hardening and Gas-Nitriding are two prominent examples of treatments applied to modular junctions. Roller Hardening[1] compresses the metal on the taper by rolling it under pressure. This makes the metal denser in this area and increases the strength of the taper by more than 50%. The strength claim of the Roller Hardened tapers is 950lbs. Prior to application of the process, the taper tested at 300lbs[2]. The Gas-Nitriding process hardens the surface of the material and makes it more resistant to wear through dissolution of nitrogen into the titanium substrate. The surface of the titanium material is hardened by exposure to an atmosphere of molecular nitrogen gas at a process temperature range of 750°F to 1300° F[3].

LPB Fatigue Testing Performance

The Low Plasticity Burnishing process greatly improves the performance of the taper junction in the AcuMatch M-Series. The fatigue strength of the M-Series neck segment was 1050 lbs at 10 million cycles prior to application of the LPB process. After the LPB process was applied, the fatigue strength increased 33% to 1400 lbs at 10 million cycles.[4]

References:

1. U.S. Patent # 6,067,701
2. Data on file at Biomet
3. U.S. Patent # 5,326,362
4. Data on file at Exactech

Technical Data sheet sponsored by:

Exactech, Inc.
2320 NW 66th Court
Gainesville, Florida 32653
1-800-EXACTECH
www.exac.com

711-13-80 0705