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Research paper

Reliability assessment in advanced nanocomposite materials for orthopaedic applications

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ABSTRACT

Alumina-zirconia nano-composites were recently developed as alternative bearing materials for orthopedics. Previous, preliminary reports show that such alumina-zirconia nanocomposites exhibit high crack resistance and low wear rate. In this paper, additional information is given in terms of wear, crack resistance and ageing behaviour: femoral heads are inspected after 7 million cycles of wear testing on a hip simulator, crack resistance is measured and compared to other ceramics used today in orthopedics, slow crack growth is reported under static and cyclic fatigue, and aging resistance is assessed. We also report on the load to failure of femoral heads prototypes during compression tests. This overall reliability assessment ensures a potential future development for these kinds of new nanocomposites in the orthopedic field.

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1. Introduction

Nowadays, the main issue for THR is the generation of wear debris produced mainly by the acetabular component (Campbell et al., 2004). Standard artificial hip joints consist of a polymer cup made of Ultrahigh Molecular Weight

Polyethylene (UHMWPE), placed in the acetabulum via a metal-back component, and a metal (stainless steel or cobalt chromium alloy) ball fixed to a metal stem introduced in the femur. Any use of the joint results in cyclic stress of the polymer cup against the metal ball. During the reciprocating motion of normal joint use, UHMWPE fibrils are then

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