Workshop »Coatings for Biomedical Applications«

Determining wear of a biomedically coated total knee system manufactured out of titanium under highly demanding activities

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The aim of this research was to carry out a rigorous knee wear simulation for highly demanding activities (HDA) to evaluate the wear properties of a multi-layer coating on the articulating condylar surface areas in sliding contact. Generally, joint replacement materials are well tolerated and biocompatible, however CoCrMo can cause a hypersensitivity reaction in the patient due to metal ions, which include nickel, chromium, and cobalt [1]. To reduce the risk for patients suffering from this metal hypersensitivity, titanium presents an alternative metal with good biocompatibility and a low reactivity due to its passive oxide layer. However, titanium used in implants (Ti6Al4V) is known to have a lower wear resistance compared to CoCrMo. To compensate for this lower wear resistance, a novel approach is explored in this research where biomedically coated condyles of a knee implant are tested for wear under HDA load profiles [2,3].

For testing, a load-controlled 3 + 1 station knee wear simulator (EndoLab GmbH, Thansau, Germany) will be utilized. This simulator can replicate the HDA loads and movements over a course of 5 million cycles, which equates to an in vivo time between 15 and 30 years. The load and motion profiles used in the simulation were derived from in vivo measurements obtained from 8 patients with instrumented implants [4]. Gravimetric wear rate will be measured after 2 million cycles of HDA testing and should be similar or better than the wear results of CoCrMo knee systems with multilayer coated articulating condylar surface areas in sliding contact. Afterwards, bone particles will be added to the system to simulate for third body wear. Ion analysis will be measured at 0.5, 1, 2, 3, 4, and 5 million HDA cycles by inductively coupled plasma mass spectrometry. It is expected to see no sign of the base material, as well as no cracking nor delamination of the coating. Thus, in turn presenting a viable “of the shelf” alternative for patients suffering from metal hypersensitivity.

References

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