Workshop »Coatings for Biomedical Applications«

Performance of DLC coatings on Knee and Spine Replacements

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The numbers of joint replacements, and surgeries in spine, trauma and sports medicine are continually growing because of population growth, increased lifespan, and increasingly younger patients. Total knee replacements are estimated to last 15 – 20 years in the human body before a revision is needed. Wear and tear of the implants can lead to loosening or breakage of the implant and are reasons for revision surgeries. These durability issues open an opportunity for highly resistant DLC coatings that improve the surface properties of orthopaedic implants and thus their longevity. Long term clinical data on DLC coated spine and lumbar discs, show substantial progress regarding the coating design and coating application process. However, data of worst-case scenarios such as abrasive tests, and low substrate qualities or different substrate materials are not yet published in detail.

This study investigates the performance DLC coated devices and test sample compared to uncoated devices and test samples. The DLC coatings are deposited by PACVD on knee and spine components and test samples made of CoCrMo and TiAlV. The surface quality prior to coating is recorded by confocal microscopy, optical microscopy and scanning electron microscopy including energy-dispersive X-ray spectroscopy to measure possible substrate contamination. These methods provide qualitative and quantitative criterion on the surface quality of the parts. The substrates are coated with DLC and submitted to simulator tests according to ISO 14243-1 and ASTM F732. Subsequently, the surface quality after coating and testing is recorded again.

Our results show a superior performance of coated devices made of TiAlV and high quality CoCrMo surfaces. While the performance suffers on uncoated and coated devices if significant substrate defects such as holes in the CoCrMo alloy are present. Additionally, coated devices show much less ion release and corrosion compared to uncoated devices. In summary, DLC coatings deposited PACVD processes on implant devices present a clear benefit for the patient as reduced PE wear rates, ion release, and corrosion is observed. An improved lifetime and less revision surgeries are expected. High quality devices are still requisite for the successful implantation.