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101 million cycle simulator wear characterization of diamond like carbon coated CoCrMo articulating implants

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Diamond like carbon (DLC) coatings have been proven to be an excellent choice for wear reduction in many technical applications. However, for successful adaption to the field of medical devices (e. g. artificial joints or joint prostheses), layer performance, stability and adhesion in realistic physiological setups are very important and not consistently investigated. Wear tests in simplified (spine) simulators as well as corrosion tests are of great importance to verify the long term stability of such a DLC coated articulating implants in the human body. Commonly one million cycles of simulator testing correspond to 1 year of articulation in the human body. Diamond like carbon coatings were deposited on CoCrMo biomedical implant alloy using a plasma-activated chemical vapor deposition (PACVD) process. As an adhesion promoting interlayer tantalum films were deposited using magnetron sputtering.
It is shown that metal-on-metal (MoM) pairs perform well up to 5 million loading cycles, after which they start to generate wear volumes in excess of 20 times those of DLC-coated implants. This is attributed to the slight roughening observed on unprotected metal surfaces during the exposure as usually also observed in-vivo. The DLC on DLC inlay pairs show comparable low volume losses throughout the full testing cycle (up to 101 million cycles over a period of three years and two month). To our knowledge this is the first time a simulator test of a DLC-coated articulating implant running for more than 100 million (corresponding to over 100 years of articulation in-vivo) cycles is presented. Within this time these implants were characterized by high wear resistance, low friction coefficients, high corrosion resistance and low defect growth. These results were obtained by means of optical microscopy, SEM/EDX, FIB cross section and profilometry. The coatings were further analyzed using XRD and XPS.

Keywords
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