Nouvelle Génération de Revêtements Céramiques pour les Implants et les instruments médicaux

"New Generation of Ceramic Coatings on Implants and Medical Instruments"

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Abstract

The spectrum of ceramic coatings and their application on implants, surgical instruments and medical tools increases steadily, calling for innovative coatings, application technologies and processes. Ceramic coatings on metallic joint replacements inhibit the metal ion release from the bulk material and prevent its corrosion as well as wear, while the toughness of the bulk material is preserved. Considering implant bearing surfaces; the UHMWPE-coating contact is substantially preferred over the UHMWPE-metal contact since less wear debris are generated inhibiting a possible inflammation. Thus, the coating application on metallic implants decreases the risk of inflammation and revision surgeries. Therefore, the coating appears to improve the lives of patients and contributes the reduction of costs in healthcare.

We present results on the performance of the latest generation of bio-compatible coatings (SiN, TiN, TiNbN and a-C:H) deposited to a thickness of ~ 5 µm on different substrate materials (steel 1.2379, CoCrMo, TiAlV) as well as joint replacements. Industrial pulsed magnetron sputtering and plasma activated chemical vapor deposition units were utilized for the deposition. The coatings were analyzed to investigate their composition, structure and performance. A reduction of the average surface roughness from >75 nm to <25 nm was achieved and hardness values of up to 30 GPa together with an improved wear resistance were obtained for coatings with Metal-to-Nitrogen ratios ≤1 as well as a-C:H coatings. Hip Simulator tests (according to ISO14242-1:2014) reveal a significant wear reduction of highly crosslinked polyethylene (HXLPE) inlays upon deposition of TiN. All coating materials reduced the Cr and Co ion release from the joint replacements by at least ten times, while TiN was most efficient inhibiting toxic ion release.

Additionally, coating developments for surgical instruments are discussed with a special focus on a-C:H coatings. a-C:H coatings represent extensive improvements regarding anti-reflection properties, cleaning and sterilization cycles.