World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:17, No:07, 2023

Morphological and Chemical Characterization of the Surface of Orthopedic Implant Materials

Authors : Bertalan Jillek, Péter Szabó, Judit Kopniczky, István Szabó, Balázs Patczai, Kinga Turzó

Abstract : Hip and knee prostheses are one of the most frequently used medical implants, that can significantly improve patients' quality of life. Long term success and biointegration of these prostheses depend on several factors, like bulk and surface characteristics, construction and biocompatibility of the material. The applied surgical technique, the general health condition and life-quality of the patient are also determinant factors. Medical devices used in orthopedic surgeries have different surfaces depending on their function inside the human body. Surface roughness of these implants determines the interaction with the surrounding tissues. Numerous modifications have been applied in the recent decades to improve a specific property of an implant. Our goal was to compare the surface characteristics of typical implant materials used in orthopedic surgery and traumatology. Morphological and chemical structure of Vortex plate anodized titanium, cemented THR (total hip replacement) stem high nitrogen REX steel (SS), uncemented THR stem and cup titanium (Ti) alloy with titanium plasma spray coating (TPS), cemented cup and uncemented acetabular liner HXL and UHMWPE and TKR (total knee replacement) femoral component CoCrMo alloy (Sanatmetal Ltd, Hungary) discs were examined. Visualization and elemental analysis were made by scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS). Surface roughness was determined by atomic force microscopy (AFM) and profilometry. SEM and AFM revealed the morphological and roughness features of the examined materials. TPS Ti presented the highest Ra value (25 ± 2 µm, followed by CoCrMo alloy (535 ± 19 nm), Ti (227 ± 15 nm) and stainless steel (170 ± 11 nm). The roughness of the HXL and UHMWPE surfaces was in the same range, 147 ± 13 nm and 144 ± 15 nm, respectively. EDS confirmed typical elements on the investigated prosthesis materials: Vortex plate Ti (Ti, O, P); TPS Ti (Ti, O, Al); SS (Fe, Cr, Ni, C) CoCrMo (Co, Cr, Mo), HXL (C, Al, Ni) and UHMWPE (C, Al). The results indicate that the surface of prosthesis materials have significantly different features and the applied investigation methods are suitable for their characterization. Contact angle measurements and in vitro cell culture testing are further planned to test their surface energy characteristics and biocompatibility.

Keywords : morphology, PE, roughness, titanium
Conference Title : ICMBA 2023 : International Conference on Metallic Biomaterials and Alloys
Conference Location : Vienna, Austria
Conference Dates : July 24-25, 2023