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Tribological behaviour of DLC(H) coatings doped with Zr for biomedical applications

Ana Escudeiro[1], Tomas Polcar[2], Albano Cavaleiro[3]

[1]SEG-CEMUC University of Coimbra, Coimbra, Portugal [2]National Centre for Advanced Tribology (nCATS), School of Engineering Sciences, University of Southampton, Southampton, United Kingdom [3]SEG-CEMUC Department of Mechanical Engineering, University of Coimbra, Coimbra, Portugal

ana.escudeiro@dem.uc.pt

This study presents the influence of the addition of Zr into DLC coatings (with and without hydrogen) on the structural, mechanical and, mainly, tribological properties. Zr was selected as doped metal due to an envisaged improvement on the mechanical properties, on the corrosive resistance giving to the coatings an excellent hemocompatibility. The coatings were deposited using a dc unbalanced magnetron sputtering device with two targets (graphite with Zr pellets and Ti target) in reactive (Ar+CH4) and non-reactive (Ar) atmospheres. In order to improve the adhesion two interfaces were applied: (i) a Ti/TiN interlayer and (ii) a TiCN gradient layer. The Zr content was varied by controlling the number of Zr pellets in the C+Zr target. All coatings were deposited onto polished Ti grade 2 and Ti grade 5 substrates. Coatings were characterised with respect to structure, adhesion, and mechanical properties. Based on the results of characterization the optimum Zr content was selected for further studies. Tribological tests were performed using unidirectional and multidirectional testing devices in physiological solution and fetal bovine serum. Different materials were used as counterparts: i) steel balls coated by identical DLC or metal-doped DLC coating, ii) Polyether-ether ketone (PEEK), and iii) Co-Cr alloys. The shape of the pin was adjusted to reach contact pressures similar to that in real knee (~50MPa). Moreover, the main aim was to analyze the interaction of the coating surface with bovine serum in order to understand their behavior in biological environment. The surfaces in the contact were thoroughly examined by SEM/EDX, 3D profilometry, Raman spectroscopy and XPS. The friction and wear resistance was then related with contact conditions and coatings fundamental properties.

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