

Elaboration and Evaluation of a Variety of Thin Hydrogenated Carbon Coatings on Polyetheretherketone for Biomedical Implants

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Poly-aryl-ether-ether-ketone (PEEK) is a polymeric biomaterial whose high Young's modulus allows it to be used in load bearing applications in arthroplasty [1]. In particular, PEEK-on-PEEK couples have been of interest for motion preservation spinal implants. Despite the good properties of PEEK, there is currently no definite benefit, in terms of wear rates, in using a PEEK-on-PEEK couple for spinal implants compared with the reference CoCr-UHMWPE couple [2][3]. On the other hand, thin hydrogenated carbon coatings have been studied as coatings aiming at reducing wear and thus improving the lifespan of implants [4].

This study focuses on evaluating and comparing the physico-chemical, mechanical and tribological properties of different thin hydrogenated carbon coatings on PEEK. More precisely, four different coatings were obtained from a hydrocarbon gas by Plasma Enhanced Chemical Vapor Deposition (PECVD). Those four coatings were obtained under different bias voltages and with or without a polarizing titanium layer obtained by cathodic magnetron sputtering.

The physico-chemical properties of surfaces were assessed and compared by wetting, topographical analyses and X-ray photoelectron spectroscopy. Particular attention was paid to the adhesive, scratch and nano-hardness properties of the hydrogenated carbon-PEEK combinations as well as to the residual stress in the coatings: a relationship between residual stress, scratch resistance and nano-hardness was established. The tribological performances of the different hydrogenated carbon-PEEK combinations were investigated by rubbing against alumina balls under physiological conditions and evaluated in terms of coefficient of friction and wear rate and compared to the PEEK surface reference.

[1] S. Kurtz, PEEK Biomaterials Handbook Chapter 13 (2012) 201-220

[2] Grupp et al., Biomaterials 31 (2010) 553-531

[3] Xin et al., Wear 303 (2013) 473-479

[4] R. Hauert et al., Surface & Coatings Technology 223 (2013) 119-130