BIO-TRIBOLOGICAL PROPERTIES AND MICROSTRUCTURE OF SEMICRYSTALLINE Al2O3/PEEK COATINGS ELECTROPHORETICALLY DEPOSITED ON THE Ti-13Nb-13Zr ALLOY

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Tribological applications of titanium alloys in orthopedic surgery and traumatology are limited due to their low resistance to wear and low hardness [1]. Therefore, in order to protect of the alloy surface and improve the performance of titanium alloys in orthopedic implants in friction and wear applications, for example, in the head and acetabulum of endoprostheses, surface treatment is necessary. Electrophoretic deposition (EPD) is a very convenient method for producing the composite ceramic-polymer coatings on metallic substrates. Polyetheretherketone (PEEK) and PEEK-based coatings have often been applied as a sliding material in bio-tribosystems because of their high wear resistance, corrosion resistance and self-lubricating capacity [2-4]. In our previous study, we successfully deposited a well-adhered PEEK coating which improved bio-tribological properties of the Ti-13Nb-13Zr alloy substrate [4]. In the present work, composite Al_2O_3/PEEK coatings deposited by EPD were applied for further improvement the bio-tribological properties of the Ti-13Nb-13Zr alloy. The deposits exhibited the uniform distribution of powders used for deposition. The PEEK in the as-deposited coatings had a nearly amorphous structure. Subsequent heating at a temperature above the PEEK melting point, 350 ºC, enabled homogeneous, semi-crystalline PEEK as a coatings matrix with spherulitic morphology to be produced (Fig. 1). TEM investigation revealed the presence of uniformly distributed γ-Al_2O_3 nanoparticles as well as agglomerates of both α-Al_2O_3 and γ-Al_2O_3 particles within the PEEK matrix. The coating thickness depended strongly on the time of EPD and equalled 45 μm, 80 μm and 120 μm after 20 s, 30 s and 60 s, respectively. Micro-scratch tests showed that all the coatings exhibited very good adhesion to the titanium alloy substrate, however, the thickest coating had the best adhesion. The composite Al_2O_3/PEEK coatings significantly improved the tribological properties of the Ti-13Nb-13Zr alloy, also in comparison with a polymer PEEK coated alloy. The Al_2O_3/PEEK coated alloy exhibited excellent wear resistance in comparison with uncoated ones and was better than the PEEK coated alloy. The coefficient of friction was reduced from 0.55 for an uncoated alloy to 0.30 and below 0.20 for the Al_2O_3/PEEK coated alloy in dry sliding and sliding in Ringer's solution, respectively. The coatings increase the corrosion resistance of the alloy in Ringer's solution at a temperature of 37 ºC.

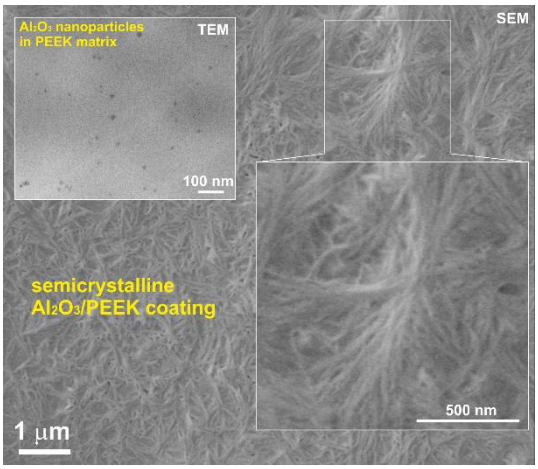

Figure 1 – SEM secondary electron image of the 45 μm thick Al_2O_3/PEEK coating on the Ti-13Nb-13Zr alloy after heating. TEM image is inserted in the upper left corner

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