[P168]

Carbon-based coatings for cardiovascular stents

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Appearance of coronary stents has made a revolution in the healing of intravascular occlusions. These implants usually made of corrosion resistant alloys like medical grade stainless steel. It was found that these materials could cause negative side-effects because of their thrombogenity which can be eliminated by covering of the stent surface with appropriate material.

Diamond like amorphous carbon (DLC) film being a biocompatible protective coating material of high hardness, low friction and chemical inertness was found to be a good choice for coating of stents. As a result today DLC coated stents are available on the market.

The coating on a stent has to fulfil different requirements compare to orthopedic implants. There is no intense mechanical wearing and stress inside the brook so the high hardness of the layer is not necessary. It is more important for the film to stand the large deformation during the crimping to the balloon and expansion inside the vessel which require high elasticity of the material. Additionally, it would be a great improvement to develop a layer with functionalizable surface with the aim of immobilization of drugs facilitating the convalescence.

DLC is a only particular type of amorphous carbon (a-C:H) materials, whose properties can be varied in a wide range depending on preparation conditions. Polymer-like a-C:H thin films have lower hardness compare to DLC but they also biocompatible and have higher surface area and elasticity. Its surface can be modified chemically relatively easy, which make them a good candidate as stent coating material of the future.

In this work the usability of polymer-like amorphous carbon (a-C:H) thin layers is demonstrated as protective coating of Tentaur® cardiovascular stents made of 316L stainless steel. DLC coatings were also prepared for comparison. The layer surface morphology was studied by scanning electron

microscopy (SEM) and atomic force microscopy (AFM), its bonding configuration by Raman spectroscopy. Fatigue testing in form of sonication in ultrasonic bath and a two-day flow-through test with blood plasma was also performed. It was found that the polymer-like a-C:H layers have smooth surface. They stand the crimping and the expansion processes without detectable scratches and detachment from the surface. Besides the sp^3 hybridized carbon atoms the films contains a large amount of sp^2 hybridized carbon and hydrogen too. No significant changes were found in the surface morphology and bonding configuration of the coating after the fatigue testing.

Keywords: cardiavascular stent, amorphous carbon, morphology, fatigue test