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Influence of pulsed bias voltage on the tribological and morphological properties of DLC coatings deposited by an anodic arc method

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In order to reduce friction and wear on metal joint implants and increase their biocompatibility, thin nanostructured diamond-like carbon (DLC) coatings are applied. This is done in a PVD process, in which an arc is ignited by means of DC-discharge between two graphite electrodes.
The arc is maintained for a period of 180 seconds while the distance of the evaporating graphite electrodes is kept constant. During coating process the substrates are subjected to different negative pulsed bias voltages, whose frequency and pulse width are variable.
The deposited layers are then analyzed with Raman-Spectroscopy to determine the ratio of sp^2 and sp^3 bonds, whereby the density of the layers can be estimated. The thicknesses of coatings are measured using a profilometer. Together with the difference of the weight before and after coating process, the density can also be calculated and compared with the results of Raman-Spectroscopy.
Subsequently, the coated substrates are, in pairs, exposed to a fretting test in a medium of demineralized water with a tribometer. Here the coefficient of friction is investigated and correlated with the likewise conducted roughness test. The abrasion particles are made available for expertise in a scanning electron microscope by microfiltration and their size distribution is determined by means of a laser diffraction spectrometer.
The aim of this investigation was to expose the influence of the bias voltage on the tribological and morphological properties of DLC coatings in particular in the range of -750 V to -1200 V bias.
It was found that an increment of the negative bias voltage results in a lower density and roughness of the layers and in addition, the ratio of large abrasive particles continuously decreases. This leads to a significant improvement of the biocompatibility and thus to an increasing durability of joint implants.

Keywords
diamond-like carbon
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Raman-Spectroscopy
particle size distribution