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Adhesion and tribological properties of gradient designed a-C film on ultrahigh molecular weight polyethylene

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Abstract

Amorphous carbon (a-C) film is deposited with a gradient designed bias voltage on the ultrahigh molecular weight polyethylene (UHMWPE) substrates and Si_3N_4 balls via a closed field unbalanced magnetron sputtering. The designed bias voltage continuously increases from -40 V to -80 V with two different increasing rate. The film with a thickness of approximately 1000 nm is made up of equiaxed grains with size of around 20 nm. Nanoindentation tests show that the hardness of the UHMWPE increases from 44 MPa to 2.16 GPa after deposition of a-C film with gradient designed bias voltage. The wear rate and friction coefficient of the a-C film sliding against a-C films coated on Si_3N_4 balls is tested in air and Hank's solution by means of a reciprocating tribometer. The a-C film deposited with gradient bias voltage exhibits superior adhesion and tribological performance, compared with those deposited with balanced bias voltage. The a-C film wearing against Si_3N_4 balls with a-C film coating shows a lower wear rate, compared with a-C films wearing against

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