The influence of corrosion on diamond-like carbon topography and friction at the nanoscale

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Abstract

The influence of corrosion upon the nanoscale topography and friction response of a hydrogenated amorphous carbon film (a-C:H) was investigated. Electrochemical atomic force microscopy was used to characterise topographical changes to the coating at two oxidative potentials. Corrosion of the coating at 1.5 V (corrosion rate 0.5 nm hr-1) resulted in no changes to the nanoscale topography; whereas corrosion at 2.5 V (corrosion rate 26.4 nm hr^{-1}) caused the root mean square roughness of the a-C:H film topography to decrease, but the local fine-scale irregularity or 'jaggedness' of the surface to increase. X-ray photoelectron spectroscopy revealed that corrosion at both potentials oxidised the a-C:H surface to form alcohol, carbonyl and carboxyl groups. Lateral force microscopy and adhesion force measurements showed that both the friction force and surface adhesion of the coating increased upon corrosion. The outcome was attributed to the surface oxidation that had occurred at both oxidative potentials, resulting in several potential mechanisms including increased attractive intermolecular interactions and capillary forces. The highest friction coefficient was observed for the a-C:H film corroded at 2.5 V, and identified as a consequence of the jagged surface topography promoting an interlocking friction mechanism.

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