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Hard graphite-like hydrogenated amorphous carbon grown by a remote plasma on steel substrates for tribological applications

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Recently we reported on a novel form of graphite-like hydrogenated amorphous carbon with a bi-modal FTIR spectrum in the C-H stretching region deposited by an expanding thermal remote plasma in an Ar - C_2H_2 environment [1, 2]. The plasma chemistry is key in understanding the deposition process and therefore the C_xH_y species present in the background of the reactor are investigated with a mass spectrometer as a function of the argon to acetylene flow ratio. A striking observation is that C_4H_2 and C_6H_2 radicals are present abundantly in the background for the conditions in which the dense graphite-like carbon material is formed. Under these conditions, the carbon radicals in the plasma beam have an increased residence time, which favours the formation channels for C_3H_x radicals at the substrate level, radicals responsible for the growth of dense carbon material in an ETP environment [3]. The graphite-like material is also very smooth, with RMS roughness below 3 nm for film thicknesses above 1µm, which make these hard graphite-like films ideal candidates for tribological applications. However, dense a-C:H material commonly leads to high compressive stress, which in turn causes poor adhesion on metallic substrates. The influence of a Ti metallic interlayer in between M2 steel substrates and the hard graphite-like films is investigated by monitoring adhesion with the Rockwell C test and the scratch test as a function of carbon film thickness, interlayer thickness and deposition temperature. It is shown that a sputtered Ti interlayer deposited at substrate temperatures of 200 - 250°C and with an adjusted thickness dependant on the carbon film thickness improves the adhesion dramatically.

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Keywords
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