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Pyrolytic carbon surfaces investigated by atomic force microscopy

A. Pfrang[1], Th. Schimmel[1, 2]

[1] Institute of Applied Physics, University of Karlsruhe, D-76128 Karlsruhe, Germany

[2] Institute of Nanotechnology, Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany

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The evolution of the micro- and nanostructure of pyrolytic carbon determines the properties of the resulting pyrocarbon layers and materials. Here, we use atomic force microscopy to study the micro- and nanostructure of native pyrolytic carbon surfaces at different stages of pyrolytic carbon deposition from the nucleation process to the formation of a complete film. Pyrolytic carbon was deposited in a hot-wall reactor at 1100 °C on different substrates at residence times up to 4 s. Deposition times between 5 minutes and a few 100 h were chosen. Methane / argon mixtures or pure methane at total pressures up to 100 kPa were used.

All surfaces exhibit a granular surface structure. The typical average island diameter was 100 nm and deviations larger than 50 % from this value were only rarely observed. Minimum and maximum average grain sizes were 50 nm and 300 nm, respectively.

For the initial stages of pyrolytic carbon deposition, three nucleation mechanisms were observed: random nucleation, nucleation along lines and the preferred nucleation at the edges of already existing islands. This 'secondary nucleation' might play an important role for the development of the surface morphology as a correlation between island size, deposition rate and degree of texture was observed under certain conditions.

[1] A. Pfrang. Von den Frühstadien der Pyrokohlenstoffabscheidung bis zum Kompositwerkstoff - Untersuchungen mit Rastersondenverfahren. PhD thesis, University of Karlsruhe, Verlag Dr. Hut, München (2005), ISBN 3-89963-133-1.