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Comparative Study of Pyrocarbon Microstructure by Atomic Force, Transmission Electron and Polarized Light Microscopy

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Carbon-carbon composites are of great technological as well as scientific interest, and there is a need for a more detailed understanding of their microstructure and its implications on the resulting mechanical properties. However, when studying carbon-carbon composites with transmission electron microscopy (TEM), the interpretation of the obtained data is not clear mainly due to possible effects of sample preparation on TEM image contrast.

To study this question, we have investigated the influence of topography and heterogeneous etching behavior of different carbon microstructures due to TEM sample preparation on the resulting TEM image data. In our experiments, pyrocarbon matrix layers in composites obtained by chemical vapor infiltration of carbon fiber felts were comparatively studied by atomic force microscopy (AFM), transmission electron microscopy and polarized light microscopy (PLM). The influence of mechanical polishing and ion etching on pyrocarbon with different textures is investigated. The AFM surface topography of the ion etched samples is compared with TEM image amplitude contrast and corresponding electron diffraction patterns as well as with polarized light microscopy. It is shown that the roughness value R_q and height differences extracted from AFM cross sections are correlated with amplitude contrast variations, radial broadening of the carbon 00l reflections and extinction angles.