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Adhesion Imaging of Carbon Fiber Reinforced Materials in the Pulsed Force Mode of the AFM

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Abstract

The microstructure and microscopic mechanical and adhesive properties of carbon fiber bundles infiltrated with pyrolytic carbon were investigated using a combination of different scanning force techniques. Contact mode atomic force microscopy (AFM) imaging was combined with lateral force imaging and with adhesion force and local stiffness imaging in the pulse force mode of the AFM. A clear material contrast was obtained between carbon fiber and pyrocarbon matrix in the adhesion and stiffness images as well as in the friction force images, which gives valuable information about the different microscopic properties of fiber and matrix. The significantly higher adhesive forces determined on the fibers as compared to the carbon matrix may be attributed to a higher concentration of polar groups on the fiber cross-sections due to the high degree of orientation of the graphene layers along the fiber axis. In addition, a much higher degree of spatial variation of adhesive and frictional forces is observed within the fiber as compared to the matrix, indicating a higher degree of homogeneity within the pyrocarbon matrix. The data derived from the experiments give microscopic information which is essential for a more detailed understanding of the resulting macroscopic properties of these materials.

Keywords

Pulsed Force, AFM, Carbon, CVI, CFC.