Heraeus-Seminar Integrating Friction and Wear Research, Ilmenau, 2002.

Growth, Adhesion and Wear of Pyrolytic Carbon Thin Films Studied on the Nanometer Scale

A. Pfrang[1], W. Send[2], D. Gerthsen[2] and Th. Schimmel[1]

[1]Institute of Applied Physics, Universität Karlsruhe, D-76128 Karlsruhe, Germany
[2]Laboratory for Electron Microscopy, Universität Karlsruhe, D-76128 Karlsruhe, Germany

Carbon coatings are used in a wide variety of applications, e.g as protective coatings on magnetic hard disks. In addition to their interesting mechanical properties, which can be tuned by deposition conditions, they exhibit a high temperature stability. For most applications, a thorough understanding of their tribological properties, the adhesion between carbon layer and substrate and the processes leading to tribochemical wear is of great interest.

Here, we report on atomic force microscopy studies investigating layer adhesion and wear of pyrolytic carbon films. For this purpose, carbon was deposited on a silicon substrate in a hot wall reactor at 1100°C. In the early stages of the deposition process, carbon islands with typical diameters between 30 nm and 150 nm are formed on the substrate. By combining lateral force microscopy and force modulation microscopy, a clear material contrast is observed between carbon islands and substrate. By applying defined lateral forces between the AFM tip and individual islands, the force per island area can be estimated which is necessary to delaminate individual islands from the substrate. In addition to island growth and substrate adhesion, processes of AFM-tip induced tribochemical wear are studied and quantitatively analyzed.