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Layer Adhesion and Tribochemical Wear of Pyrolytic Carbon Films Investigated by Atomic Force Microscopy

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Due to their mechanical properties and their temperature stability, pyrolytic carbon coatings are used in a wide variety of applications. Therefore, 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. In lateral force 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 determined which is necessary to delaminate individual islands from the substrate. In addition, processes of AFM-tip induced tribochemical wear were studied and quantitatively analyzed in situ during the AFM scan.