NANOTRIBOLOGY AND SURFACE CHEMISTRY OF CARBON-BASED THIN FILMS EXPOSED TO ELEVATED TEMPERATURES

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The need for low friction, low adhesive materials for MEMS and NEMS devices is ever increasing. Recently there is increased interest in studying the nanotribology of carbon-based materials exposed to elevated temperatures for stress relief, processing needs, or harsh-environment applications. We have investigated the nanotribology (friction and adhesion) and the surface chemistry (adsorbates and bonding hybridization) of two types of diamond-like carbon (DLC) films, grown by room temperature deposition techniques, and then exposed to elevated temperatures ranging from 300-800 ^{0}C. One, known as tetrahedral amorphous carbon (ta-C), and is grown with a Pulsed Laser Deposition (PLD) technique. It is nearly hydrogen-free and contains a high (~80%) amount of sp3-bonded carbon. The other is grown with the Plasma Immersion Ion Implantation and Deposition (PIIID) technique, which is a unique non-line-of-sight method. This film is a hydrogenated DLC with a lower amount of sp3-bonded carbon (30-50%). The nanotribology of carbon-on-carbon interfaces is studied quantitatively with atomic force microscopy (AFM) utilizing silicon AFM tips coated with diamond, DLC, or ta-C. The surface chemistry and bonding are probed by total electron- and fluorescence-yield near edge x-ray absorption fine structure (NEXAFS) spectroscopy to distinguish between near-surface and deeper ("bulk") changes in the film. We quantify the temperature ranges at which structural and chemical changes occur on the surfaces, and find that these changes are correlated with specific changes in the nano-scale frictional properties of the interfaces.

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