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Structural, nanomechanical, and nanotribological characterization of human hair and conditioner using atomic force microscopy and nanoindentation

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Human hair is a nanocomposite biological fiber. Maintaining the health, feel, shine, color, softness, and overall aesthetics of the hair is highly desired. Hair care products such as shampoos and conditioners, along with damaging processes such as chemical dyeing and permanent wave treatments, affect the maintenance and grooming process and are important to study because they alter many hair properties. Nanoscale characterization of the cellular structure, mechanical properties, and morphological, frictional, and adhesive properties (tribological properties) of hair are essential to evaluate and develop better cosmetic products, and to advance the understanding of biological and cosmetic science. The tensile response of hair is of considerable interest. Another property of interest is the surface charge of hair, which has a significant effect on manageability, feel, and appearance. For this reason, controlling charge buildup to improve these factors is an important issue in the commercial hair care industry. The atomic/friction force microscope (AFM/FFM) and nanoindenter have recently become important tools for studying the micro/nanoscale properties of human hair. In this talk, we present a comprehensive review of the cellular structural, nanomechanical, and nanotribological properties of various hair and skin as a function of ethnicity, damage, conditioning treatment, and various environments1-2. Various cellular structures of human hair and fine sublamellar structures of the cuticle are identified and studied. Nanomechanical properties such as hardness, elastic modulus, creep and scratch resistance are discussed. Nanotribological properties such as roughness, friction, and adhesion are presented, as well as investigations of conditioner distribution, thickness, and binding interactions.

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