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Mechanical properties of a-SiC:H films: an influence of surface topography on nanoindentation measurements

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Hydrogenated amorphous silicon-carbon films were prepared on polished silicon wafers from a tetravinylsilane precursor via plasma-enhanced chemical vapor deposition. The grain structure was developed at the film surface using high powers (50-70 W), as observed by atomic force microscopy (AFM). Conventional and cyclic nanoindentation measurements revealed different mechanical responses for indentation into and outside of the selected isolated grain with a spherical cap geometry with a radius greater than that of the indenter (50 nm). The finite element method was employed to simulate the behavior of the grain under deformation by an indenter to correctly interpret the nanoindentation data. Scanning probe measurements using Modulus Mapping (dynamic mechanical analysis) and atomic force acoustic microscopy confirmed that the surface topography had a critical influence on the determined mechanical properties, which were significantly underestimated. Our experimental and simulation study demonstrates that nanoindentation and scanning probe measurements must be performed on strictly flat surfaces. This conclusion applies to all AFM measurements performed in contact and semi-contact mode used to characterize mechanical properties based on the geometry of the contact. Modulus Mapping may potentially be used to characterize the mechanical properties of a specimen with rough surfaces if the surface topography is known with high spatial resolution.

Keywords
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