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Role of interface in nanocrystalline diamond film internal friction
THOMAS METCALF, XIAO LIU, BRIAN HOUSTON, JAMES BUTLER, Naval Research Laboratory, TATYANA FEYGELSON, GeoCenters, Inc. — Nanocrystalline diamond films are an emergent material for use in the fabrication of nanoscale mechanical devices. Because the performance of many mechanical structures is limited by the internal friction of the material from which they are made, understanding the origin of the internal friction of these materials is essential for developing high-quality films and devices. Recent experiments suggest that the mechanical loss of a nanocrystalline diamond film is dominated by the so-called transition region, the initial growth surface of a film that is composed of growing crystallites before they coalesce into a film. This partially amorphous layer is thought to have a substantially higher internal friction than the fully dense nanocrystalline film that subsequently grows. To investigate this, we have prepared several 0.5 μm thick nanocrystalline diamond films in which the thickness of the transition region varies over a large range. The internal friction and shear modulus of the films were measured between 0.4 K and room temperature. The films are grown on silicon double paddle oscillator substrates, which have an extremely low background internal friction to permit sensitive measurements of film mechanical properties. Subsequent to measurement, the substrate is etched away so that the transition layer of the film can be examined and its characteristics correlated with the film measurements.

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