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Temperature dependence of mechanical stiffness and dissipation in ultrananocrystalline diamond resonators VIVEKANANDA ADIGA, University of Pennsylvania, ANIRUDHA SUMANT, Argonne National Laboratory, SAMPATH SURESH, CHRIS GUDEMAN, Innovative Micro Technology, ORLANDO AUCIELLO, Argonne National Laboratory, JOHN CARLISLE, Advanced Diamond Technologies, ROBERT CARPICK, university of pennsylvania — We have studied the mechanical softening and dissipation of ultrananocrystalline diamond (UNCD) resonators with temperature. Resonant excitation and ring down measurements were conducted under ultra high vacuum (UHV) conditions in a decoupled UHV atomic force microscope (AFM) to determine the Young's Modulus and quality factor (Q) in UNCD cantilever structures. The temperature dependence of Young's modulus revealed the characteristic Wachtman's empirical relation. From this measurement the Debye temperature was estimated to be $\sim 1460\,^{\circ}$K, significantly lower than Debye temperature of $1860\,^{\circ}$K for single crystal diamond. The quality factors of different resonators increased as the cantilevers were cooled from $300\,^{\circ}$K to $30\,^{\circ}$K and with the hydrogen termination of the cantilever surface. The results indicate that surface and bulk defects significantly contribute to the observed dissipation as well as the mechanical softening in UNCD resonators.

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