Measurement of Non-Local Deformation Using Nanodiamond Sensors

R B Liu[1,2,3] and Q Li[1,2,3]

[1] *Department of Physics, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong*
[2] *Centre for Quantum Coherence, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong*
[3] *The Hong Kong Institute of Quantum Information Science and Technology, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong*
Contact Email: rbliu@cuhk.edu.hk

Nitrogen-vacancy (NV) center spins in diamond are good quantum sensors for their long quantum coherence times. The resonance frequencies of the NV center spins in diamond depend on the angle between the crystallographic axes and the external magnetic field and therefore the rotation of a nanodiamond can be monitored by following the magnetic resonance spectra of the NV centers. In turn, the rotation of nanodiamonds placed on the surface of a material can be employed to map the deformation of the material. We demonstrated the measurement of deformation of soft materials and fixed cells using nanodiamond sensors via the rotation measurement. This measurement can detect the intrinsic material properties free of the specific parameters of the nano-tips used to induce the deformation such as their size, shape, and surface textures, since the measurement of the deformation is carried out in a non-local manner, that is, at a location well separated in distance from the indentation. The precision of the measurement can be better than 10 nanometers and the lateral resolution is up to the resolution of the atomic-force imaging. This deformation measurement enabled by nanodiamond sensors provides a new approach to studying the mechanical materials of soft materials and live cells.

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