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Strain broadening of the 1042-nm zero phonon line of the NV- center in diamond: A promising spectroscopic tool for defect tomography

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Abstract

© 2017 American Physical Society. The negatively charged nitrogen-vacancy (NV-) center in diamond is a promising candidate for many quantum applications. Here, we examine the splitting and broadening of the center's infrared (IR) zero-phonon line (ZPL). We develop a model for these effects that accounts for the strain induced by photodependent microscopic distributions of defects. We apply this model to interpret observed variations of the IR ZPL shape with temperature and photoexcitation conditions. We identify an anomalous temperature-dependent broadening mechanism and that defects other than the substitutional nitrogen center significantly contribute to strain broadening. The former conclusion suggests the presence of a strong Jahn-Teller effect in the center's singlet levels and the latter indicates that major sources of broadening are yet to be identified. These conclusions have important implications for the understanding of the center and the engineering of diamond quantum devices. Finally, we propose that, once the major sources of broadening are identified, the IR ZPL has the potential to be a sensitive spectroscopic tool for probing microscopic strain fields and performing defect tomography.

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