Color centers in large-area hBN as local sensors of nanomagnetic properties

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Color centers in hexagonal boron nitride (hBN) have recently attracted significant attention due to their potential applications in quantum technologies, particularly as single-photon emitters and highly sensitive probes of strain and magnetic fields.

In this work, we investigate the interplay between defects in epitaxially grown hBN and an adjacent two-dimensional magnetic material. Specifically, we study heterostructures consisting of hBN grown by MOVPE and the layered 2D magnet chromium thiophosphate ($CrPS_4$) (Fig. 1a). Through temperature- and magnetic-field-dependent measurements, we observe pronounced changes in the emission spectra of hBN color centers. In temperature-dependent experiments, a significant shift in the defect-related emission energy is observed across the paramagnetic–antiferromagnetic phase transition of $CrPS_4$. Similarly, under an external magnetic field, we detect a drastic reduction in emission intensity accompanied by an energy shift, which closely correlates with the spin-flop transition in the 2D magnet.

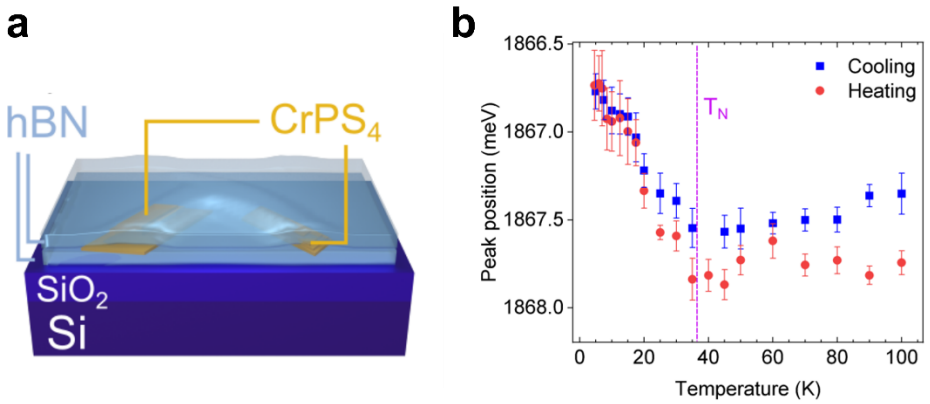

Fig 1: a) Schematic drawing of the sample structure, b) Temperature-dependent shift of the emission spectra of hBN color centers. (T_N- Néel temperature of $CrPS_4$)

Experimental evidence indicates that these effects are driven by local tensile strain induced by the magnetic state of the adjacent material. These findings demonstrate that optical probing of such heterostructures enables the use of point defects in epitaxial hBN as atomic-scale, ultrasensitive sensors of the state of adjacent nanomaterials

[1] P. Tatarczak et al. Adv. Funct. Mater. 36, e26312 (2026)

[2] A. Gottscholl et al. Nature Communications 12:4480 (2021)