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Multimodal Sensing with Single-Crystal Diamond Needles

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We report multimodal sensing based on single-crystal diamond needles as a platform for nanoscale metrology. Their high crystalline quality and well-defined geometry provide high sensitivity and stability for quantum and optothermal measurements.

The approach integrates complementary mechanisms, including nitrogen-vacancy (NV^-) center ODMR thermometry, silicon-vacancy (SiV^-) all-optical thermometry, and pH-sensitive photoluminescence for surface probing. Cross-validation between SiV^- and NV^- thermometry improves measurement reliability through independent sensing channels.

Surface-dependent photoluminescence variations further enable detection of local chemical environment changes, including pH, supporting multifunctional quantum sensing.

Overall, diamond needles offer a versatile platform for high-resolution, multi-parameter sensing with cross-validated accuracy across physical and chemical modalities.