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Temperature-dependent fluorescence of color centers in diamond structures

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Diamond color centers are promising in quantum and optical biosensing due to diamond's biocompatibility and easy functionalization [1]. NV, SiV and GeV color centers are investigated for their potential in quantum and optical sensing of magnetic fields, electric fields and temperature. However, there are hundreds of other diamond color centers in diamond [2]. They are interesting because of their unknown fundamental properties and potential applications in biosensing. In this work, fluorescence behavior of 389 nm, 468 nm and NV^0 color centers in diamond microneedles was investigated in the biological temperature range (298 K – 338 K).

Conducted experiments revealed 389 nm, 468 nm and NV^0 color centers in diamond microneedles. 468 nm color center was not observed in a bulk diamond sample. 389 nm and 468 nm color centers in diamond microneedles exhibit a linear fluorescence intensity dependence on temperature. However, the 389 nm color center in bulk diamond showed a nonlinear fluorescence quenching behavior. In case of NV^0 color center, the nonlinear fluorescence intensity dependence on temperature was observed. Most investigated color centers did not show a significant fluorescence lifetime temperature dependence, however, lifetimes, measured at 468 nm color center phonon sideband show a linear decrease with increasing temperature. Another parameter that could be useful in optical thermometry and was extracted from the measured spectra is ZPL and PSB intensity ratio, which changes with increasing temperature in case of NV^0 color center.

The observed changes in fluorescence spectra and kinetics (changes in fluorescence intensity, ZPL and PSB intensity ratio, and fluorescence lifetimes) demonstrate the potential for all-optical temperature sensing, while also provide new fundamental insights into 389 nm and 468 nm color centers in diamond.

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REFERENCES

[1] J. Zhang, L. Ma, Y. Hou et al.; *Advanced Drug Delivery Reviews* **221** (2025) 16 p.
[2] A. M. Zaitsev, *Optical Properties of Diamond: a Data Handbook*, 3rd ed., Bochum: Springer (2000) 486 p.