

### Cathodoluminescence-based nano-thermometry

#### General Scope:

The performance optimization of optoelectronic devices requires a precise knowledge of the semiconductor materials properties at the nanoscale. If temperature is one of the most basic parameters influencing any physical or chemical process, the traditional strategies to measure temperature cannot easily be applied to the nanoscale. Among the different solutions, temperature dependent luminescence properties of nano-diamonds have proven to be good contact-free temperature sensors, with a resolution only limited by the light diffraction. This technique allows to reach a spatial resolution of 500 nm at best.

#### Research topic and facilities available:

In this context, the aim of this internship is to combine electron and optical microscopy techniques to develop the next generation of temperature nano-sensing (expected spatial resolution: 50 nm).

Indeed, thanks to their reduced wavelength, fast electrons can be used as a highly localized excitation source for luminescence measurements. This technique is called cathodoluminescence (CL) spectroscopy. At Néel, you will benefit from a dedicated, state-of-the-art CL setup combining cryogenic temperatures (4 K-300 K), fast electronics (50 ps) and optical access.

During his/her internship, the student will start by probing the optical properties of nano-diamonds as a function of temperature and monitor the nanoprobe emission characteristics (energy shifts, carrier lifetime...) as a function of the temperature. The developed method will find practical applications as a new tool to investigate nanoscale heat transfer, a process of not only fundamental interest but also technological importance.

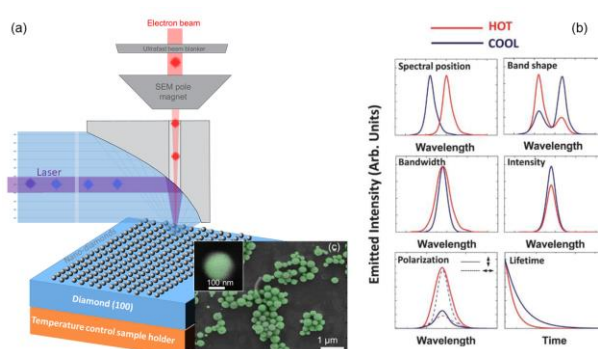


Figure 1. (a) Schematic of the experimental setup coupling electron and light excitation. (b) Schematic representation of the possible effects caused by a temperature increment on the luminescence

**Possible collaboration and networking:** This research is carried out at Institut Néel, in collaboration with other researchers from the laboratory and from other laboratories (CEA-IRIG, EPFL...)

**Possible extension as a PhD:** Possibility of continuation as a PhD on the same subject with funding already secured

**Required skills:** the candidate should have a master 2 in Nanosciences or equivalent, with a marked interest in experimental physics and optics.

**Starting date:** Flexible, from January to April 2022

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