Thermometry based on luminescence spectroscopy from cavities in Ga_2O_3:Cr micro- and nanowires

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The ultra-wide bandgap semiconductor gallium oxide (β-Ga_2O_3) is currently attracting great interest for high power electronics [1]. Photonics applications are being parallelly explored, especially for solar-blind UV photodetectors and tuneable emitters from the near-UV to the IR [1].

In this work, further applications of β-Ga_2O_3 in the field of nanophotonics are explored within nanowires [2]. These cavities consist of pairs of distributed Bragg reflectors (DBR) created by focused ion beam (FIB) in previously grown nanowires, resulting in widely tuneable Fabry-Perot (FP) optical resonances. A complete analysis of their photonic behaviour has been carried out both experimentally and with finite-difference time-domain (FDTD) simulations. Both approaches agree with each other and allow to predict and optimize the design and performance of the cavities.

We have developed a thermometer based on photoluminescence (PL) spectroscopy analysis of β-Ga_2O_3:Cr microcavities [3]. Thermal shifts of two different PL features are monitored: the characteristic R-lines of Cr^{3+} ions and the FP resonances emitted by the cavity. The former mechanism is optimum for low temperatures up to room temperature, while the latter can still be observed up to 550 K with a precision around 1 K and a full width at half maximum of the FP peaks nearly unchanged in this temperature range. These temperature sensors present a wide dynamic range, high spatial resolution, very high thermal and chemical stability and can be used in harsh environments, ideal for high electronic/optical power devices, among other applications.

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