A versatile nanowire-based nanophotonic platform for the UV/VIS range

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Subwavelength nanowires (NWs) positioned in grooved Si photonic crystal (PhC) waveguides have recently been shown to be a promising platform to achieve high quality factor nanocavities and nanolasers operating at telecommunication wavelengths [1,2]. Its main limitation stems from the absorption cut-off of silicon that prevents NWs emitting at wavelengths shorter than 1 μm to be used. This limitation can be circumvented by using silicon nitride instead of silicon, providing that the system is properly designed [3]. We here demonstrate that the design is versatile enough to be successfully implemented in the UV and visible ranges with various materials such as ZnO NWs [4] and $CsPbBr_3$ perovskite NWs (Fig. 1a). In such cavities, we achieve resolution-limited quality factors larger than $Q_{exp} = 2.1 \times 10^3$ for a mode volume $V_m = 3.4(\lambda/n_r^{SiN})^3$, as deduced from three-dimensional finite-difference time-domain calculations. We also demonstrate that the degree of freedom along the groove can be used to move NW-induced nanocavities in space, to position them deterministically in PhCs of different lattice constants (Fig. 1b) and in turn to tune their optical properties (Fig. 1c): not only can we shift the resonant wavelength of the NW-induced nanocavity but we can adjust absorption losses and control the cavity to NW coupling. The versatility of our multimaterial NW-based nanophotonic platform opens the path toward the realization of novel devices including movable and tunable NW nanolasers operating across the UV/VIS range.

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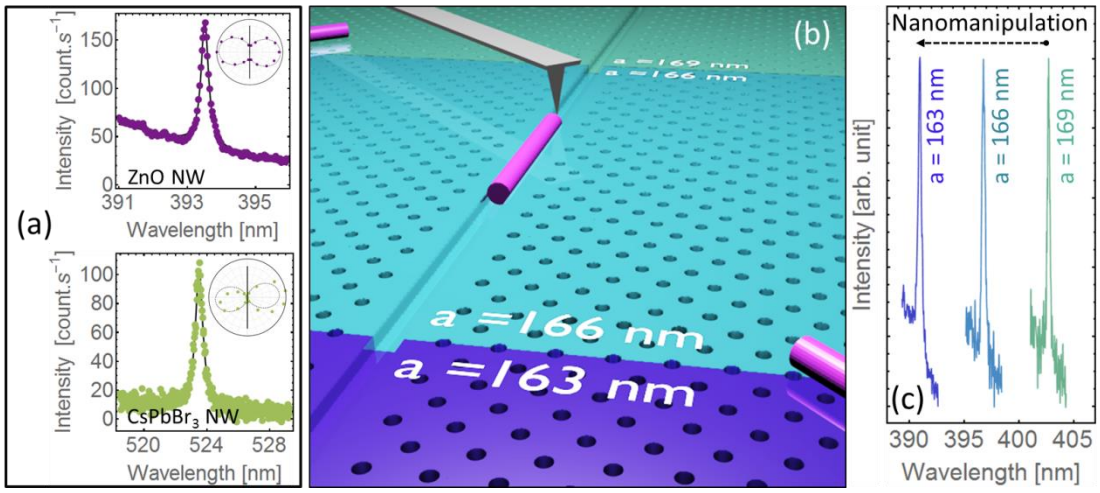

Figure 1. (a) Microphotoluminescence (μPL) spectra and polarization properties of the fundamental resonance for ZnO and $CsPbBr_3$ NW nanocavities. (b) Schematics of a NW-induced nanocavity system and its manipulation. (c) μPL spectra of the fundamental cavity mode as a single ZnO NW is manipulated across PhCs of lattice constants 169, 166 and 163 nm.

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