Nanomanipulating and tuning ultraviolet ZnO-nanowire-induced photonic crystal nanocavities

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1. Absence of intrinsic resonance in ZnO nanowires

To confirm the absence of Fabry-Pérot resonances in the nanowires (NWs) investigated in this work, we perform 3D-FDTD calculations of ZnO NWs with $\delta = 90nm$, the largest diameter used in this work to fabricate ZnO-NW-induced photonic crystal (PhC) nanocavities. Three configurations are considered: a bare NW, a NW sitting on top of an unpatterned SiN slab and a NW positioned inside a groove with no surrounding PhC. The broadband light source is spectrally centered at 350 nm and the magnetic field component $|H_y|$ is calculated at the center of the NW or at the SiN/NW interface. The calculated amplitudes of the magnetic field component $|H_y|$ shows that optical modes are not allowed in the range of the ZnO NW emission and the NW-induced PhC nanocavity modes investigated in our work (Figure S1). The result holds for the magnetic field calculated both at the center of the NW and at the lower SiN/NW interface, suggesting that hybrid modes localized at the SiN/NW interface are not present in the structure. This result is confirmed by the microphotoluminescence (μPL) spectra of NWs positioned on a SiN slab and in a groove that do not show any intrinsic resonance.

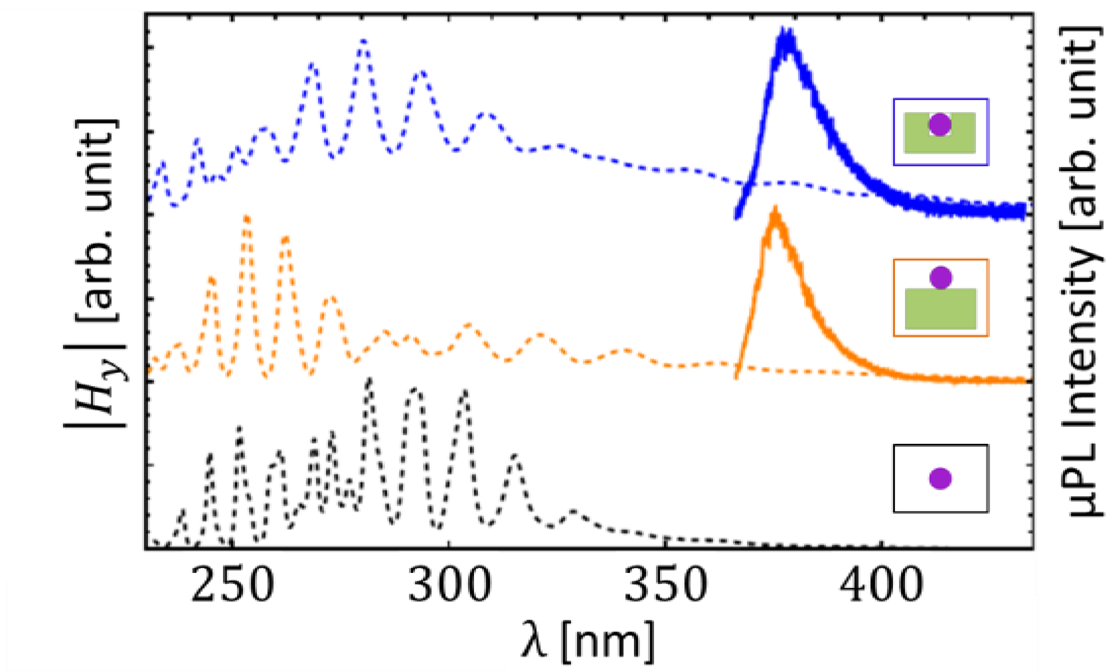

Figure S1. Magnetic field component $|H_y|$ as calculated by 3D-FDTD for ZnO NWs with $\delta = 90nm$, (dashed lines) and μPL emission spectra of single ZnO-NWs (solid lines). The black, yellow and blue lines correspond to three configurations schematically represented in insets: respectively a bare NW in vacuum, a NW sitting on top of an unpatterned SiN slab and a NW positioned in a groove without any surrounding PhC.

2. Fabrication imperfections and optical losses

We address the impact of fabrication imperfections on the quality factor of ZnO-NW-induced PhC nanocavities: misalignment δ_x along the x axis between the groove and the center of the PhC waveguide, mismatch δ_y between the groove depth d and the diameter of the NW δ, misalignment $\delta_{x,NW}$ along the x axis between the NW and the center of the groove, presence of defects on the NW wall.

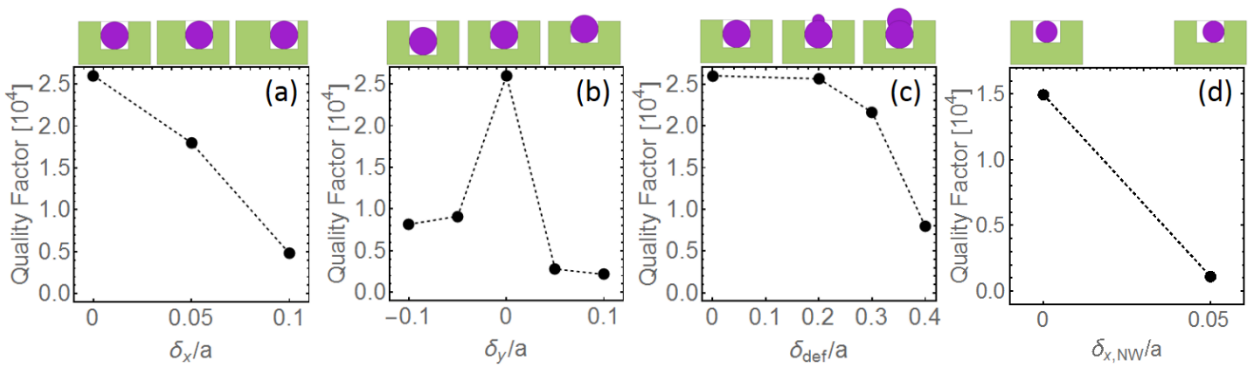

Figure S2. (a) Quality factor as a function of δ_x. (b) Quality factor as a function of δ_y. (c) Quality factor as a function of δ_{def}, the diameter of spherical defects positioned on the NW walls. (d) Quality factor as a function of $\delta_{x,NW}$ for $\delta = d = 0.35a$, $w = 0.45a$. Unless specified otherwise, all the design parameters used in these calculations are identical to the one described in the main text. In each panel, cross-sections of the cavity core are shown for various data points.