Low-threshold lasing at high temperatures in subwavelength-nanowire nanocavities integrated in photonic crystal waveguides

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Because of their unique properties, semiconductor nanowires have been key building blocks for a range of advanced devices such as nanolasers or single photon detectors and emitters. There has been a great deal of interest in integrating such unique objects in photonic platforms for information processing and sensing applications. Our group has especially focused on subwavelength nanowires for their ultrasmall dimensions and their potential for compact and energy-efficient photonic devices. We have thus integrated subwavelength nanowires in photonic crystal waveguides [1-5] and photonic crystal disks [6] for the realization of femtoJoule optical switches [1], photodetectors [2] and 10-Gb/s-modulated nanolasers operating at telecommunication wavelengths [3]. So far, such nanolasers have only been demonstrated at cryogenic temperatures but we report here that lasing action in nanowire-induced photonic crystal nanocavities can actually be obtained at room temperature and beyond.

To that end, we rely on subwavelength ZnO nanowires integrated in SiN photonic crystal waveguides. Thanks to the low optical losses of its fully dielectric design and the robust optoelectronic properties of ZnO, lasing action at room temperature is demonstrated with thresholds as low as 3.5 $MW.cm^{-2}$. This constitutes a significant improvement over previously reported subwavelength ZnO nanowire lasers based on plasmonic platforms [7]. At higher temperatures, the all-dielectric nanolaser consistently outperforms its plasmonic counterparts in terms of lasing threshold and we demonstrate subwavelength nanowire lasing up to 360 K. The results confirm the large advantage of fully dielectric nanowire-induced nanocavities for practical and energy-efficient photonic devices and applications.

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