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**On-chip Whispering-Gallery-Mode Microlasers and Their Applications for Sensing**

Whispering-Gallery-Mode (WGM) resonators are emerging as an excellent platform to study optical phenomena resulting from enhanced light-matter interactions due to their superior capability to confined photons. The monolithic fabrication process to achieve ultra-high-Q WGM resonators without the need to align multiple optical components as requested in traditional design of resonators based on precise arrangement of mirror is especially attractive. Here we explain how to process a layer of thin film doped with optical gain medium, which is prepared by wet chemical synthesis, into WGM structures on silicon wafer to achieve arrays of ultra-low threshold on-chip microlasers. We can adjust the dopant species and concentration easily by tailoring the chemical compositions in the precursor solution. Lasing in different spectral windows from visible to infrared was observed in the experiments. In particular, we investigated nanoparticle sensing applications of the on-chip WGM microlasers by taking advantages of the narrow linewidth of lasing mode and mode-splitting phenomena arising from interactions of nano-scale objects with high-quality WGMs. It has been found out that a nanoparticle could split a lasing mode in WGM resonator; subsequently a beatnote can be generated by photomixing the two split lasing modes in a photoreceiver, which, in turn, can be used as a signal to detect the nanoparticle. We have demonstrated detection of virions, dielectric and metallic nanoparticles by monitoring the changes in self-heterodyning beatnote of the split lasing modes. The built-in self-heterodyne interferometric method achieved in the monolithic microlaser provides an ultrasensitive self-referencing sensing scheme.