Optically Controlled Elastic Microcavities

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Polymeric micro-photonic structures are particularly attractive for their high quality, low cost and versatility in integrated photonics devices. A reversible and stable tuning of the optical properties provides a higher level of functionality. We present the photo-induced tuning of a whispering gallery mode (WGM) microlaser obtained by employing a liquid crystal elastomer (LCE) actuator. Taking full advantage of the mechanical properties of this material, we will demonstrate the possibility to opto-mechanically tune different polymeric integrated devices.

Polymeric microgoblet resonators [1], doped with a laser dye, are processed on a silicon substrate by electron beam lithography. Light-driven mechanical control of the lasing frequency of the structure is obtained with a LCE microcylinder positioned in the center of the PMMA cavity. The cylinders are fabricated employing direct laser writing (DLW) on a LCE mixture kept in the nematic phase [2] with the uniaxial alignment parallel to the symmetric axis of the cylinder. The WGM resonator was pumped with a nanosecond pulsed laser at 532 nm with 1 kHz repetition rate, so that the lasing modes of the resonator can be excited and the LCE cylinder can be heated up exploiting the absorption of the thermal effect dye present in the LCE mixture. Once the LCE temperature overcomes the transition temperature, a phase transition from nematic to isotropic state is induced. As a result the molecules become disordered yielding an in-plane isotropic expansion of the microcylinder, which in turn expands the goblet changing its resonance wavelength. We report a continuous reversible resonance shift up to 2 nm of the lasing modes by varying the laser pump power [3].

Exploiting the 3D high resolution of the DLW, engineered LCE structures will be integrated in 3D polymeric structures as WGM resonators and beam splitters to achieve the dynamical tuning of their optical properties in integrated circuits.

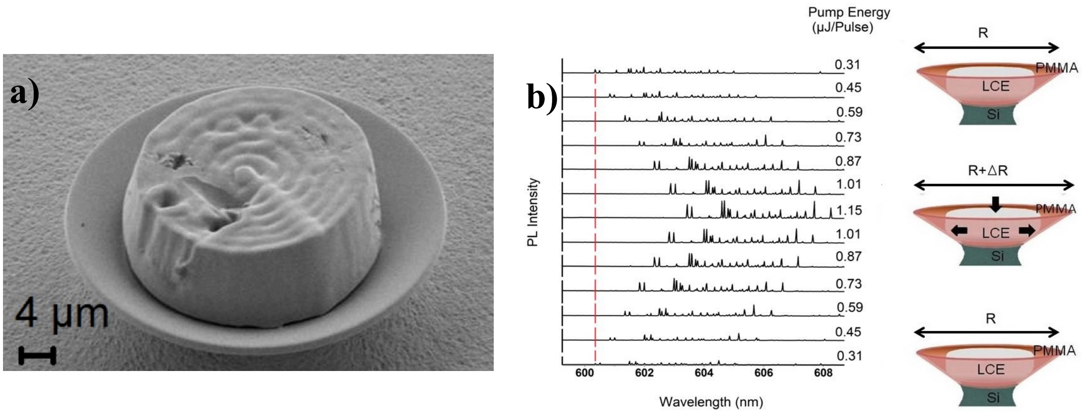

Fig. 1 a) Scanning Electron Micrograph (SEM) of the top-side view of the LCE/goblet resonator. b) Left: Photo-induced tuning of LCE/goblet laser modes for different pump energy. Right: Schematic deformation of the resonator for different laser energy.

References

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Short Biography

Sara Nocentini is a PhD student at LENS - University of Florence (Italy) -, in the group leaded by Prof. D. Wiersma. During her PhD program, she is becoming expert in the fabrication and characterization of tunable integrated polymeric circuits. The first results have been presented at PECS 2014 and in a paper accepted from *Light: Science and Application* journal. Inside the collaboration project with the group of Prof. H. Kalt, she spent a period at the Karlsruhe Institute of Technology. She took her master degree at the University of Florence with a thesis on “Three-Dimensional Polymeric Photonic Structures” in March 2013.