Novel SU8 Optical Waveguide Microgripper for Simultaneous Micromanipulation and Optical Detection

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Incorporating micro and nanostructures onto assembled systems such as hybrid system-on-chip and 3D micro-electro-mechanical-systems is important to the development of novel micro/nanoscale devices. Several microgripper devices [ref] have been proposed to carry out assembly and manipulation of nano/micro components; however, they typically require imaging for feedback. This requirement presents a challenge since imaging in the short wavelength range requires bulky and expensive systems with constraints in resolution and/or area. The integration of simultaneous sensing and manipulation onto a microgripper device enables closing the assembly loop at the microscale level, enabling array operation and added functionality.

Here we report on the design and fabrication of a novel microgripper device which is capable of manipulating microstructures while simultaneously detecting the optically excited fluorescence of the micro-scale object of interest which are barcoded with quantum-dots (QDs). By changing materials, the design is directly scalable to the sub-micron regime with waveguide cross sections of 300x300 nm^2 with functionality into the sub-100 nm through the use of near field designs. Here, devices were fabricated on SU8 polymers using standard photolithography, with pattern generated by a Heidelberg μPG101 tabletop laserwriter system. Fig. 1 shows an optical micrograph of the device assembled onto a hypodermic needle. The SU8 polymer waveguide microgripper has input optical fiber carrying green (532 nm) laser light. Also seen is the fluorescence of a QD-labeled polymer strip 15 μm thick handled by the device. Waveguides were 50 μm wide and 30 μm thick in this prototype. Fig. 2 shows the fluorescence spectra collected through the waveguide arm of the device, for three distinct QD-labeled structures placed between the facets of the microgripper device. These results show for the first time the ability to simultaneously manipulate and optically characterize a microscale object under study.

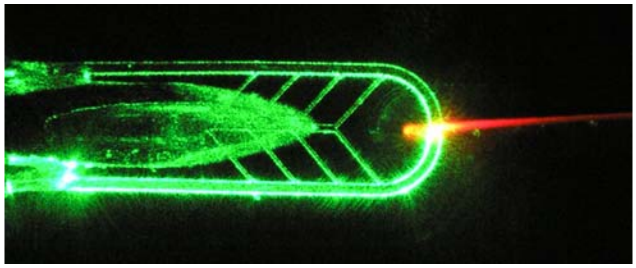

Fig. 1 – Optical micrograph of the waveguide microgripper excited by 532 nm coupled through multimode optical fiber. The microgripper is holding a 15 μm thick suspended polymer stripe doped with quantum dots.

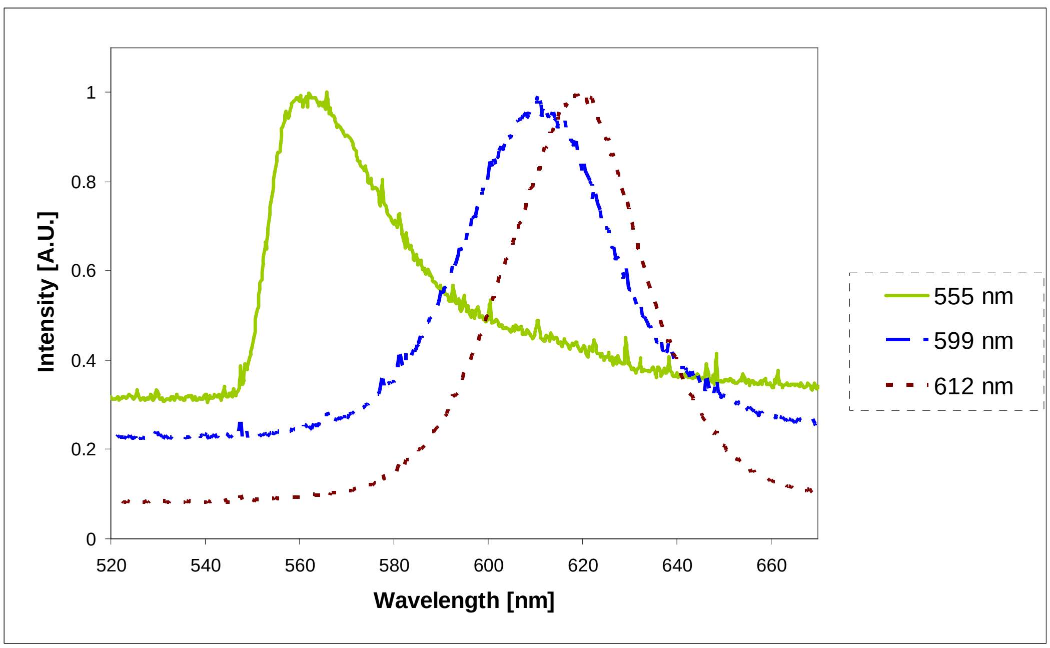

Fig 2 – Fiber-coupled fluorescence spectra obtained from the setup in Fig.1, of the light collected by the receiving waveguide. An Ocean Optics USB2000 spectrometer was used to analyze the fiber coupled fluorescence, after a 550 nm cut-off filter.