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# Optical micromanipulation of freestanding microstructures with embedded waveguides

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**Abstract:** Optically micromanipulated waveguides can be arbitrarily positioned and oriented for targeted light delivery. At the same time, controlled light deflection in designed waveguides can be exploited to exert optical forces for new optical micromanipulation modalities.

**OCIS codes:** (170.4520) Optical confinement and manipulation; (220.4000) Microstructure fabrication; (230.7370) Waveguides.

## 1. Introduction

Contemporary micro- and nanofabrication technologies enable the design and fabrication of novel synthetic structures, which can be imbibed with various features. The use of controlled optical forces enables the versatile mechanical actuation of these microstructures for various applications [1].

Our recent work focuses on the design and two-photon fabrication of free-standing waveguides, which are amenable to optical trapping and optical micromanipulation. On the one hand, free-standing waveguides can be optically positioned and oriented for targeted light delivery in three dimensions [2]. On the other hand, waveguides are highly suitable for controlling light deflection, which can be exploited to exert optical forces on the structures containing the waveguides [3]. Hence, embedded waveguides onto free-standing microstructures can serve as new handles for optical trapping and micromanipulation.

## 2. Results

Figure 1 illustrates two complementary modes for the optical micromanipulation of synthetic freestanding microstructures with embedded waveguides. In Fig. 1(a), a two-photon-polymerized microstructure is optically trapped via spherical handles to position and orient its embedded waveguide, which can then tap light from an incident broad beam and redirect illumination onto a localized target. In Fig. 1(b), the light deflections in its embedded waveguide exert force on the microstructure to move it along a trajectory defined by the illumination pattern. These complementary modes can have applications for optical excitation, sensing and micromanipulation.

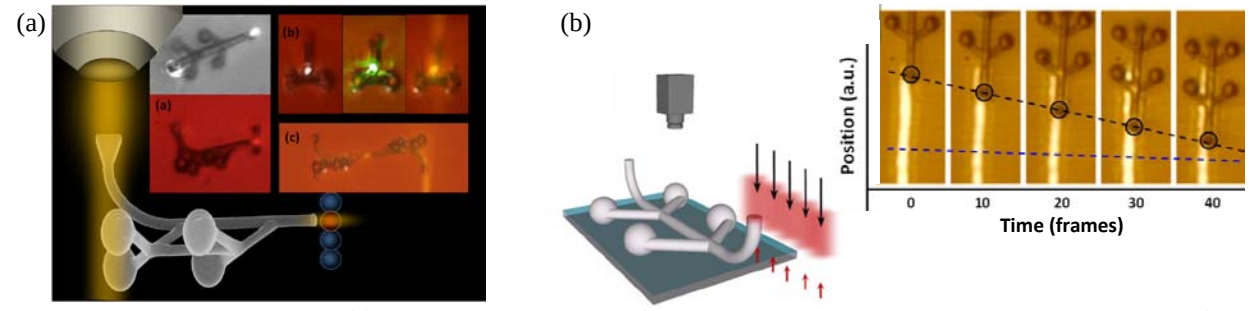


Fig. 1. Optical micromanipulation of free-standing waveguides: (a) A free-standing waveguide can be optically positioned and oriented for targeted light delivery [2]; (b) Guided light deflections can exert forces on waveguide to actuate the structure containing the waveguide [3].

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[3] D. Palima, A.R. Bañas, G. Vizsnyiczai, L. Kelemen, T. Aabo, P. Ormos, and J. Glückstad, "Optical forces through guided light deflections," *Opt. Express* **21**, 581-593 (2013).