

Manufacturing of arbitrarily-shaped active waveguides with liquid crystal cladding

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Many photonic devices are based on waveguides (WG) whose optical properties can be externally modified. These active WGs are usually obtained with electrooptic materials in either the propagating film (core) or the substrate (cladding). In the second case, the WG tunability is based on the interaction of the active material with the evanescent field of the propagating beam. Liquid crystals (LCs) are an excellent choice as electrooptic active materials since they feature high birefringence, low switching voltage, and relatively simple manufacturing.

In this work, we have explored alternative ways to prepare WGs of arbitrary shapes avoiding photolithographic steps. To do this, we have employed a UV laser unit (Spectra Physics) attached to an xyzCNC system mounted on an optical bench. The laser power is 300mW, the spot size can be reduced slightly below 1 μm , and the electromechanical positioning is well below that number. Different photoresins have been evaluated for curing time and uniformity; the results have been compared to equivalent WGs realized by standard photolithographic procedures.

Best results have been obtained with several kinds of NOA adhesives (Norland Products Inc.) and SU8 (Microchem). NOA81 optical adhesive has been employed by several groups for the preparation of microchannels [1] and microfluidic systems [2]. In our case, several NOAs having different refractive indices have been tested in order to optimize light coupling and guiding.

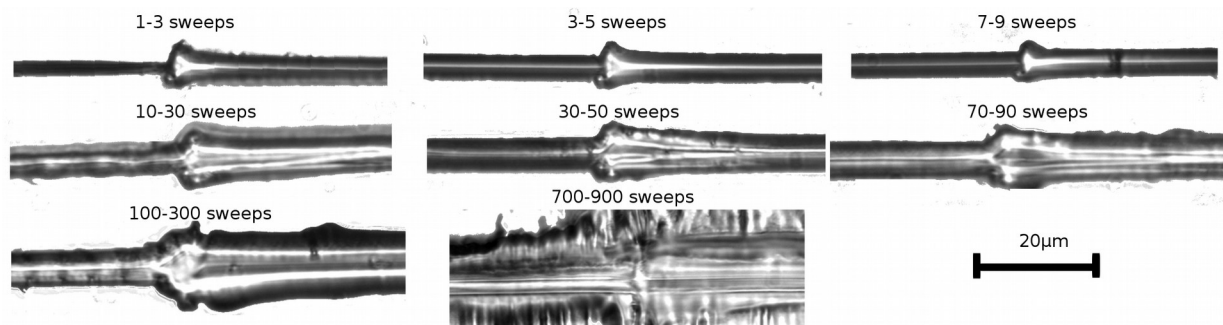


Figure 1: Selective curing of NOA81 with a 355 nm laser. The segment widths increase with the number of sweeps done by the laser

Figure 1 shows several attempts to optimize the laser-induced waveguides. The adhesive is spun onto a substrate, and a number of segmented WGs are written with the laser system. The laser power is attenuated 20 dB. Then the laser spot is swept a number of times (from 1 to 900) on every segment. It has been found that, for example, the optimum number of sweeps for NOA81 is 30-70 times (center of the figure) under these conditions. The WG dimensions obtained with this procedure are about 7 μm high and 12 μm wide.

Once the WGs have been prepared, a second substrate with ITO-coated surface is added up to make switchable LC cells. The performance of these optimized systems will be shown.

[1] P. Wägli, A. Homsy, and N. F. de Rooij, "Norland optical adhesive (NOA81) microchannels with adjustable surface properties" *Procedia Eng.*, 5, 460–463 (2010).

[2] D. Andrews, "Photonics, Volume 2: Nanophotonic Structures and Materials" Wiley, Hoboken, USA (2015) p. 288.