

Inkjet printing of elastomeric optical waveguides

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Abstract:

Optical waveguides transmit light in a controlled manner,¹ making its propagation possible over long distances, with only little and predictable loss. This gives a great advantage for optoelectronics and in wavelength sensitive biological systems,² allowing fast information transfer without electromagnetic interference.³ Typically, optical elements (e.g. printed optical circuit boards) are not required to be flexible or stretchable. However, elasticity and stretchability expand the field of waveguide application. Recent efforts focus on creating fully elastic systems, able to withstand complex deformation (stretching, twisting, bending).^{4,5}

The goal of the research was to develop a system that is compatible with an inkjet printing process and allows the fabrication of elastomeric waveguides, employing commercially available products. For that purpose the system has the following requirements:

1. The ink should compromise good printing properties and high substrate wettability. It should be chemically stable and photocurable.
2. The ink should have good elastomeric properties

after curing, and the mechanical properties of the ink should match the ones of the cladding, to avoid delamination at the waveguide/cladding interface at higher strains.

3. The cladding should have a lower refractive index than the cured ink, and this difference should be possibly big.

4. The printed channel should be homogenous, with stable contact lines, stable cross section along the long axis and possibly big contact angle. Bulge formation has to be avoided.⁶

The first three requirements are met by optimising the composition of polyurethane acrylate inks, and using PDMS as a substrate and the cladding material. Requirement 4 poses a difficult problem to overcome, since the stability of printed channels decreases for high contact angles.⁶ The contact angle can be adjusted by modifying the surface energy and viscosity of both the ink and the substrate. A method which allowed us to obtain homogenous lines with a high contact angle (see Fig. 1) is described. All structures were fabricated with a standard laboratory printer (Dimatix DMP-2831), with an attached LED lamp (Omni Cure LED, Series 1000).

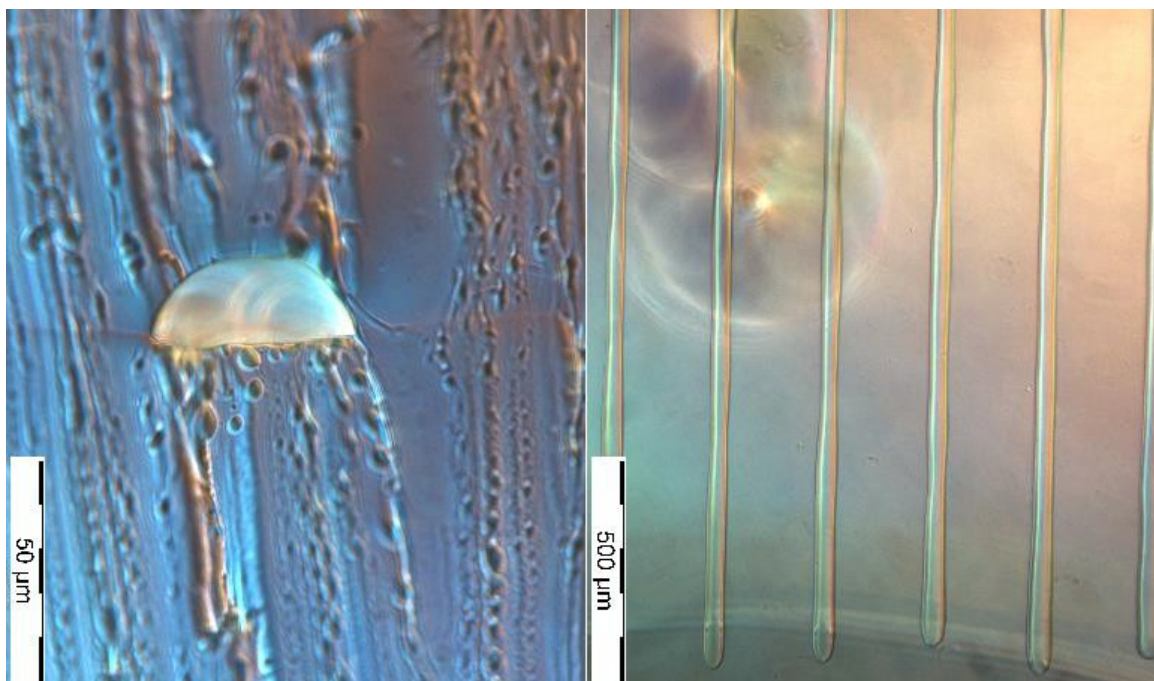


Figure 1. LEFT: A typical cross section of the printed waveguides; RIGHT: the top view of the printed waveguides

Keywords

Inkjet printing, elastomer, optical waveguides

Biography

Aleksandra Samusjew obtained her MSc in Chemical Engineering at the Gdansk University of Technology (Poland) in 2014. She is currently a PhD student in the group of Prof. Thomas Griesser at the University of Leoben (Austria). Her research interests include stretchable optical waveguides, as well as the development and application of new functional inks for food packaging and printed electronics.

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