ABSTRACT

In this paper, a thiol-ene based polymer waveguide, defined by UV-assisted soft lithography, is designed, fabricated and characterized. Waveguides are formed by filling microfluidic channels with a high refractive index liquid mixture of ‘thiol’ and ‘ene’ monomers (e.g., trimethylolpropane tris(3-mercaptopropionate) = ‘thiol’, and 1,3,5-triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione = ‘ene’), which can be cured by UV exposure into a solid polymer. The waveguides demonstrated good confinement of light, and a propagation loss of 0.5 dB/cm was obtained. To our best knowledge, this is the first report to employ thiol-ene based polymers as waveguide core materials for potential optofluidic applications.

KEYWORDS: thiol-ene, polymer waveguide, optofluidics

INTRODUCTION

Polymers based on thiol-ene chemistry, in the remainder called ‘thiol-enes’, have previously been investigated as a suitable photopolymerizable material for fabrication of nanopatterned structures [1]. Their physical and chemical properties, such as stiffness or hydrophobicity, can easily be tuned by changing the ratio of ‘thiol’ and ‘ene’ monomers. Their low viscosity before being cured allows to easily fill micro/nanoscale mold features made by soft lithography [2]. Recent work showed the great potential of thiol-enes for rapid prototyping of microfluidic devices [3], thus providing an excellent alternative to other polymer materials for microfluidics, such as, in particular, PDMS. Here, we present the fabrication and characterization of a thiol-ene based multimode waveguide. Our work demonstrates the excellent optical properties of thiol-enes as a waveguide core layer and their potential for optofluidic applications.

EXPERIMENTAL

To evaluate the optical performance, we started with a stochiometric thiol-ene material (thiol-to-ene 1:1 ratio). Figure 1 showed a comparison of the transmission properties of thiol-ene to other potential polymeric waveguiding materials (2 mm thick) by collecting transmission spectra between 300 nm to 800 nm. Thiol-ene showed high optical transparency (~91%) across the entire visible wavelength range, although thiol-ene shows more absorption than PDMS and COP at wavelengths below 360 nm. The refractive index of the thiol-ene at 635 nm is 1.57, and the extinction coefficient is 0 (Figure 2).

![Figure 1. Optical transmission spectra of thiol-ene and PDMS.](image-url)
Figure 2. Index of refraction (N) and extinction coefficient (K) measurement of thiol-ene

Figure 3 schematically illustrates the procedures for fabricating thiol-ene waveguides. Waveguides were formed by filling PDMS-glass bonded microfluidic channels with the liquid thio-lene (which has a higher refractive index), which was then polymerized by UV exposure.

RESULTS AND DISCUSSION

The thiol-ene waveguides were characterized by measuring the propagation loss using the cutback technique. The experimental setup is shown in Figure 4, where light from a 632.8 nm laser is butt-coupled to the waveguides via a multimode fiber. The output from the waveguides was collected at a detector to register the intensity variations. The inserted UV mask shown in Figure 5 is employed to define the PDMS channel structures used for filling liquid thiol-ene. The propagation loss was evaluated by plotting the waveguide attenuation loss as a function of propagation length. The propagation loss for the presented thiol-ene waveguides was found to be 0.5 dB/cm.
CONCLUSIONS

In conclusion, we present the concept for rapid production of waveguides using thiol-ene chemistry. We also demonstrated confinement of light in the waveguides and analyzed the propagation loss. The simple fabrication and the freedom in tailoring both optical and chemical properties of thiol-enes should provide excellent opportunities for use in optofluidic applications.

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REFERENCES


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