A NOVEL AIR/NANOPOROUS DIELECTRIC CLAD OPTOFLUIDIC WAVEGUIDE SYSTEM FOR SENSOR APPLICATIONS

Venumadhav Korampally, Maruf Hossain, Minseong Yun, Keshab Gangopadhyay, Luis Polo-Parada and Shubhra Gangopadhyay.

University of Missouri-Columbia, MO 65211, USA

ABSTRACT

We report a novel high throughput liquid core waveguide system (LCW) featuring water as the core and air/nanoporous dielectric as cladding and demonstrate that such miniaturized devices have a great potential as sensor platforms, particularly biosensors. Organosilicate nanoparticulate films with refractive indices as low as 1.04 have been used as the cladding material. Apart from successful integration of these coatings, we present a simplified fabrication process eliminating the need for etched microchannels. Microfluidic channels for the liquid core are formed through surface directed flows made possible through simple surface modification techniques resulting in low loss chip based LCWs.

KEYWORDS: Liquid core waveguides, nanoporous dielectrics, microfluidics, optical sensors

INTRODUCTION

The ability of the LCW to capture and confine light within its aqueous core has a great implication for fluorescence based biosensors. The aqueous core functions both as a reaction cell requiring extremely low sample volumes as well as a light amplification system whereby extremely low levels of fluorescence signals could be detected. However, low refractive index of water (n =1.33) than most readily available materials places a serious constraint on the choice of cladding materials. Thus previous designs relied heavily on the use of Teflon AF (n=1.29) as cladding [1, 2].

Nanoporous dielectrics offers many advantages over Teflon in terms of achieving ultra low refractive indices, great flexibility in chemical functionalization of the surfaces and excellent adhesion to substrates. Although feasibility of nanoporous dielectrics for LCWs has been previously demonstrated by Risk et al[3], there have been no reports to date on a complete, microfabricated LCW using nanoporous dielectrics.

THEORY AND FABRICATION

Integrating nanoporous dielectrics with the LCWs is however not trivial. Unlike Teflon, obtaining thick, crackfree and hydrophobic films is a challenge. We have developed novel ultra low refractive index (as low as 1.04), crack-free thick coatings (as thick as 3.6 microns) based on organosilicate nanoparticulate (NPO) networks. Details on the formation of these films will be published elsewhere. Figure 1 gives the cross sectional Scanning electron microscope (SEM) images of these films.

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