Near Field Investigation of Bloch Surface Based Platform for 2D Integrated Optics

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Abstract— Dielectric multilayers sustaining Bloch surface waves (BSWs) are considered as a novel platform for two dimensional (2D) integrated optics. The dielectric platform is exploited to manipulate surface waves by patterning 2D dielectric optical components on top of it. BSW shows a potential of higher propagation length and large resonance strength because of low loss characteristics of dielectric materials. Taking the advantage of high field confinement on the surface, the platform has also applications in sensing.

In order to excite a BSW, momentum of incoming beam should match with the momentum of the BSW. Therefore, we use Total internal reflection configuration for this purpose, which consists of BK7-glass prism. The schematic of the configuration and the platform is presented in Figure 1. New design of multilayer platform consists of periodic stacks of alternative SiO_2 and Si_3N_4 layers. It has been fabricated to work around the wavelengths of 1.5 µm.

In this paper, we study the key parameters, propagation length and the effective refractive index (n_{eff}), of BSW. They play an important role in characterizing losses associated with the multilayer platform and propagation of surface modes. Effective refractive index contrast (Δn) is introduced by depositing an additional layer of high refractive index material on the top of platform. It is basically the difference between n_{eff} of additional layer and platform. It plays a key role in determining the optical properties of the 2D surface photonic devices and hence their capability to manipulate the BSW most essentially. High refractive index materials, as an active material to pattern 2D optical elements on the top of the platform, have been investigated in near field and far field. These material include titanium dioxide (TiO_2), for the time being, and Graphene.

We obtained propagation length of around 2 mm for 15 nm thickness of additional TiO_2 layer with the aid of multi-heterodyne scanning near-field optical microscopy (MH-SNOM). It is around 25 times longer compare to the recently obtained "Long-Range SPPs" studied by Lin et al. [1]. We achieved Δn of around 0.2 measured in the far field with 100 nm thickness of TiO_2. It is around 3.5 times higher than the Δn obtained for same thickness of Photoresist [2].

In near future, we aim to characterize different optical components on the top of multilayer platform with the aid of MH-SNOM, for example, Ring resonators and Interferometers for the time being.

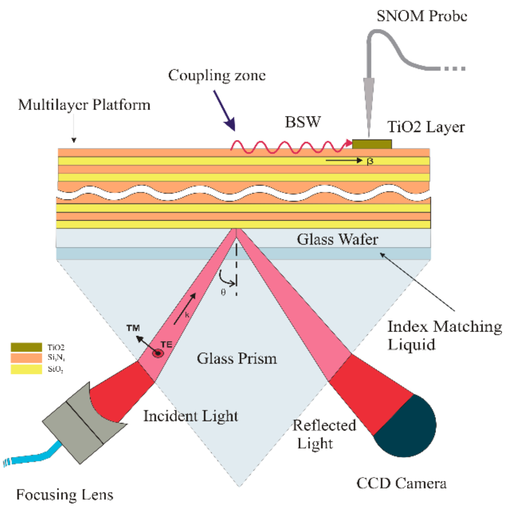

Figure 1: Total internal reflection configuration using BK7-glass prism to excite BSW.

REFERENCES

1. Lin, J., et al., *Physical Review Letters*, Vol. 109, 093904, Aug. 2012.
2. Yu, L., et al., *Light: Science & Applications*, Vol. 3, Jan. 2014.