Fabrication of passive polarization-dependent asymmetric optical devices using nanoimprint lithography

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There have been a lot of efforts in making non-reciprocal passive devices (e.g. optical isolators) with linear and isotropic materials[1-4], but the Lorentz reciprocity theorem theoretically dictates that such isolators cannot be strictly built[5]. However, under certain constraints to the system (e.g. linearly polarized light), asymmetric transmittance can be realized by linear and isotropic materials without violating the Lorentz reciprocity theorem.

As shown in figure 1, the polarization–dependent asymmetric system consists of two cascaded gratings, subwavelength dielectric grating and wire grid polarizer. The dielectric grating works as a wave plate and can rotate the polarization of light. A similar system has been theoretically proved with the asymmetric transmittance[6], but it has never been experimentally demonstrated.

Here we report of our progress on fabricating such devices. In this work, we used nanoimprint lithography[7] and reactive ion etching to fabricate large-area gratings (figure 2a, 2b). The characterizations for both gratings have been completed (figure 3a, 3b). Using two discrete gratings, the asymmetric transmittance with extinction ratio of $10^2 \sim 10^3$ was experimentally observed for TE polarized light in visible range (figure 3c). More measurement and fabrication details for compactly integrating two gratings will be presented in the conference.

References:

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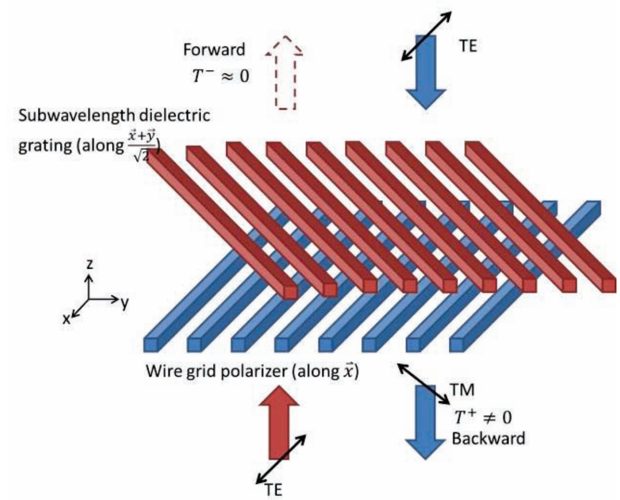

Figure 1: The schematic of a polarization-dependent asymmetric system

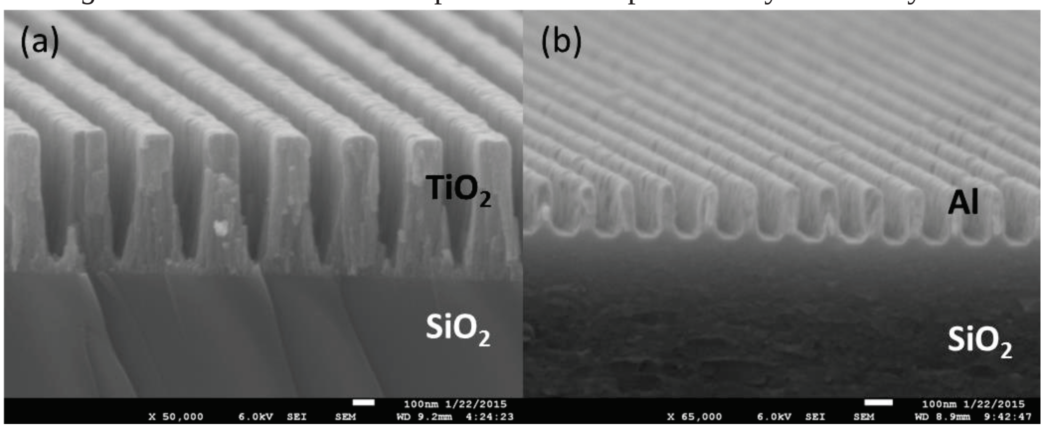

Figure 2: (a) SEM image of dielectric grating (b) SEM image of wire grid polarizer

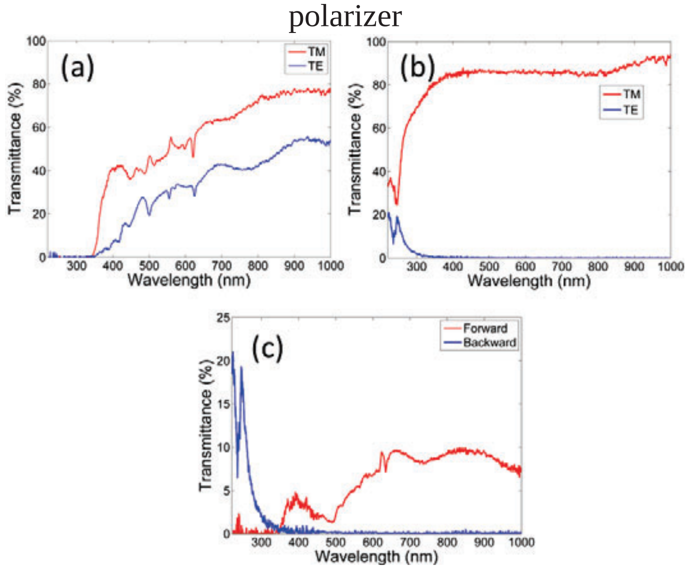

Figure 3: Measurement results: (a) Transmittance of subwavelength dielectric grating (TE and TM) (b) Transmittance of wire grid polarizer (TE and TM) (c) Forward and backward transmittance of the optical isolator (TE polarization dependent)