Transmission of the Double-layer Wire Grid Polarizer and its Dependence on the Incident Angle and the Periodical Structures

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A wire grid polarizer (WGP) is a filter-type polarizer. The advantages of WGPs compared with the prism-type polarizers are that they are thin and flat structures and able to cover a wider range of incident angle; however, the polarization character of WGPs, such as extinction ratio, is inferior to that of prism-type polarizers. Given these advantages, in this study, we used a double-layer WGP that uses a double layer of metal wire to realize a high optical extinction ratio when compared with a conventional WGP. Furthermore, the double-layer WGP offers the advantage of simplifying the fabrication by eliminating the process of removing the resist. We have already reported that we clarified the relation between structure and polarization property in double-layer WGP to obtain the optimal structure. The peak incident angle of TM transmittance is found to vary as a function of the period [1]. In this study, the detail simulation and experimental results are mentioned and try to explain on the basis of the extraordinary transmission phenomena by surface plasmons. The sample of double-layer WGP made on a glass substrate using electron beam lithography system and sputtering a Au layer. Polarization measurements were performed using a red laser of wavelength λ = 635 nm. The polarization property of the fabricated double-layer WGP was characterized for different periods by varying the incident angle from 0 degree to 70 degree. The rigorous coupling wave of analysis (RCWA) is also carried out. Fig. 1 shows the dependence of the 0th order transmission on the incident angle and the calculated magnetic field. The peak angle is 30 deg. when p is equal to 318 nm, as shown in Fig. 1a, then the maximum calculated transmittance at 30 deg. is 0.3. The magnetic field distributions are shown in Fig. 1b. The incident TM light can be transmitted to the glass substrate and a strong magnitude of the magnetic field can be obtained. Notably, in the interface between Au and glass substrate, the magnitude of the magnetic field is largest. It can be shown that only when the incident angle is identified with the exciting angle of surface plasmon polariton, the TM light can be transmitted to the glass substrate. It is suggested that the incident light passes through the resist layer from its side wall, followed by the excitation of SPPs at the interface between the resist and Au. Subsequently, the SPPs combine with the transmitted light in the glass substrate. This results in strong transmitted light with TM polarization.

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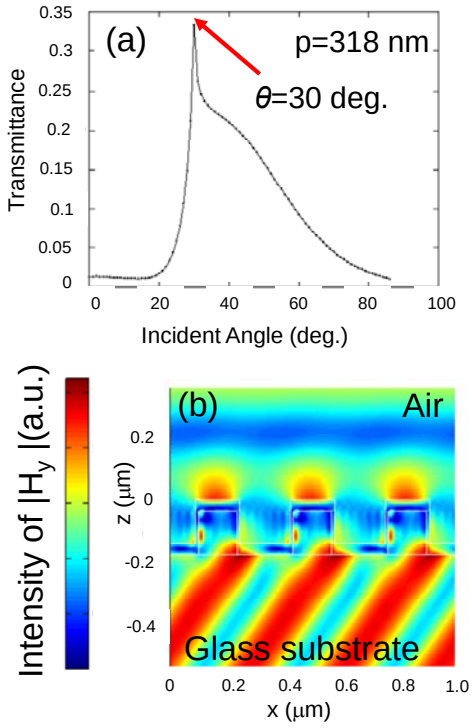

Fig.1 (a) Dependence of the 0th order transmission on the incident angle and (b) the magnetic field and their distribution on the magnetic field.

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