T-003

Analysis of Surface Plasmon Resonance on Periodic Metal Hole Array by Diffraction Orders

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Surface plasmon polaritons (SPPs) have attracted the attention of scientists and engineers involved in a wide area of research, microscopy, diagnostics and sensing. SPPs are waves that propagate along the surface of a conductor, usually metals. These are essentially light waves that are trapped on the surface because of their interaction with the free electrons of conductor. In this interaction, the free electrons respond collectively by oscillating in resonance with the light wave. The resonant interaction between the surface charge oscillation and the electromagnetic field of the light constitutes the SPPs and gives rise to its unique properties. In this papers, we studied theoretical and experimental extraordinary transmittance (T) and reflectance (R) of 2 dimensional metal hole array (2D-MHA) on GaAs in consideration of the diffraction orders. The 2d-MHAs was fabricated using ultra-violet photolithography, electron-beam evaporation and standard lift-off process with pitches ranging from 1.8 to 3.2 μm and diameter of half of pitch, and was deposited 5-nm thick layer of titanium (Ti) as an adhesion layer and 50-nm thick layer of gold (Au) on the semi-insulating GaAs substrate. We employed both the commercial software (CST Microwave Studio: Computer Simulation Technology GmbH, Darmstadt, Germany) based on a finite integration technique (FIT) and a rigorous coupled wave analysis (RCWA) to calculate transmittance and reflectance. The transmittance was measured at a normal incident, and the reflectance was measured at variable incident angle of range between 30^{o}～80^{o} with a Nicolet Fourier transmission infrared (FTIR) spectrometer with a KBr beam splitter and a MCT detector. For MHAs of pitch (P), the peaks λ max in the normal incidence transmittance spectra can be indentified approximately from SP dispersion relation, that is frequency-dependent SP wave vector (ksp). Shown in Fig. 1 is the transmission of P=2.2 um sample at normal incidence. We attribute the observation to be a result of FTIR system may be able to collect the transmitted light with higher diffraction order than 0th order. This is confirmed by calculations: for the MHAs, diffraction efficiency in (0, 0) diffracted orders is lower than in the (±x, ±y) diffracted orders. To further investigate the result, we calculated the angular dependent transmission of P=2.2 um sample (Fig. 2). The incident angle varies from 30^{o} to 70^{o} with a 10^{o} increment. We also found the splitting character on reflectance

measurement. The splitting effect is considered a results of SPPs assisted diffraction process by oblique incidence.

Keywords: Surface plasmon polaritons, Diffracted order, Transmittance, Reflectance, Rigorous coupled wave analysis (RCWA)

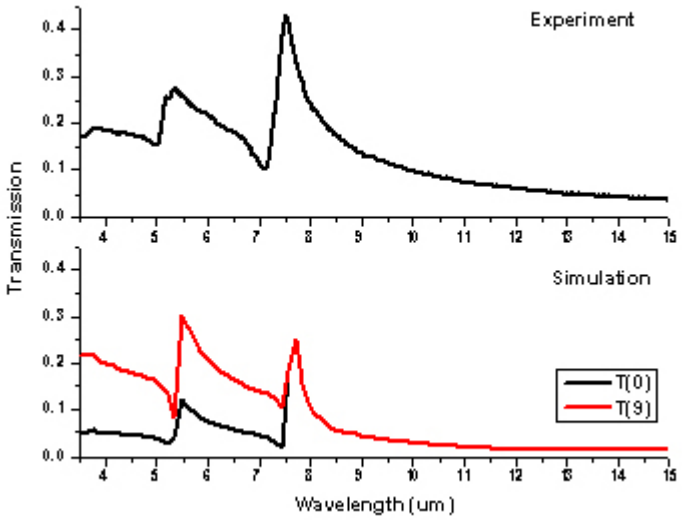

Fig. 1. Experimental and theoretical result of transmission of P=2.2 um.

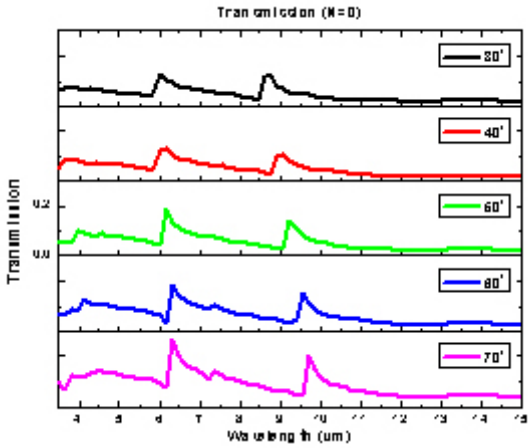

Fig. 2. Simulation of the angular dependent transmissionof P=2.2 um. The incident angle varies from 30° to 70° with a 10° increment.