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Experimental Demonstration of Enhanced Transmission Due to Impedance-matching Si_3N_4 Layer in Perforated Gold Film

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In this study, surface plasmon resonance structures for the selective and the enhanced transmission of infrared light were designed. In order to relieve the large discontinuity of refractive index between air and metal hole array, Si_3N_4 was used as the impedance matching layer. Experimental parameter were calculated and determined in advance by the rigorous coupled wave analysis (RCWA) simulation, and then the experiment was carried out. A 2-dimensional metal hole array structures were patterned on the size of 1×1 cm^2 GaAs substrate using photolithography process, and 5 nm thick Ti, 50 nm thick Au were deposited by E-beam evaporator, respectively. Subsequently, Si_3N_4 films with various thicknesses (150, 350, 550, and 750 nm) were deposited by plasma enhanced chemical vapor deposition (PECVD). For the comparison, transmittance of specimens with and without Si_3N_4 was measured using Fourier transform infrared spectroscopy (FTIR) in the range of 2.5-15 μm. Furthermore, the surface and the cross-sectional images were collected from the specimens by scanning electron microscopy (SEM). From the results, it was demonstrated that the transmittance was enhanced up to 80% by the deposition of 750 nm Si_3N_4 at 6.23 μm. It has advantage of enhanced transmission despite the simple fabrication process.

Keywords: surface plasmon, impedance matching, metal hole array, infrared

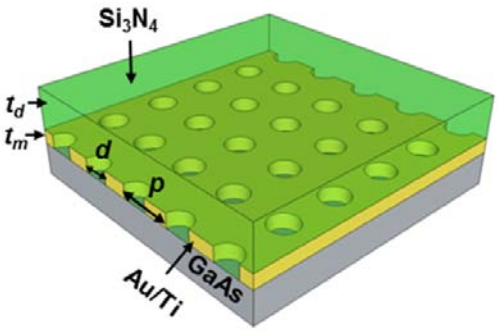

Figure 1. Sample structure (Si_3N_4/Au/Ti/GaAs)

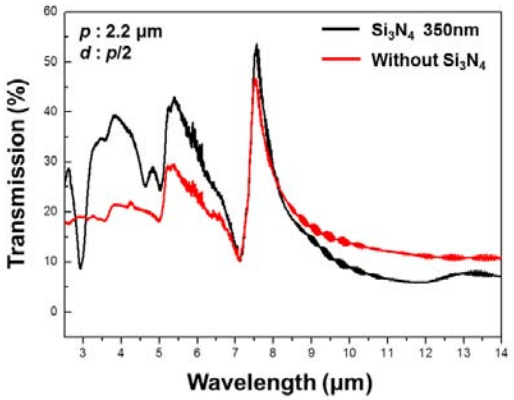

Figure 2. Transmission of 2.2 μm pitch sample with/without Si_3N_4