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# Study on the Chemical Sensor Using Excitation of the Surface Plasmon Polariton with the GaP-Au Contact

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We are studying aiming at the chemical sensor which detects a medium with high refractive index (n > 1.45) using excitation of the surface plasmon polariton (SPP) with metal-semiconductor contact. The refractive index of a semiconductor is higher than that of transparent materials like glass and sapphire, and the semiconductors such as GaP and GaN have transparent character in the visible and the near-ultraviolet light region. By combining a semiconductor material and a metallic thin film, the excitation of the SPP is expectable at the metal-semiconductor contact. On the other hand, by the attenuated total reflectance method using Kretschmann arrangement the researches on the application to the chemical sensor are carried out. However, due to using total reflection, the detection of the reflection light from the medium which the refractive index is higher than 1.45 such as carbonic acid (n = 1.65) is difficult. In this study, GaP which is transparent in the visible region with a large refractive index (n = 3.32) and a wide band gap (2.2eV) are focused. Until now, the excitation of the SPP in GaP/Au/Air, $H_2O$, and $C_2H_5OH$ was characterized by the simulation by Rigorous Coupled Wave Analysis (RCWA) method and experiment [1], [2]. In this paper, the dependence of reflectance on the thickness of Au film is reported.

When the light ($\lambda$ = 635nm) irradiates from the semiconductor side by the model of the metal-semiconductor contact shown in Fig.1 and 2, the dependence of reflectance on incident angle was calculated by the RCWA method, and the reflectance measurement was performed for the system of GaP/Au/$H_2O$ (Fig.1) and GaP/Au/$C_2H_5OH$ (Fig.2). The metal semiconductor contact, as shown in Fig.1 and 2 is fabricated by Au and 300-μm-thick GaP substrate. The dependence of reflectance on the incident angle at 635nm from the GaP side by TM polarization is shown in Fig.1 and 2. For both case, there were angles which reflectance reduce, it turned out that the peak position has shifted to the higher angle side as the refractive index is higher. From the dispersion relationship of the SPP in the GaP-Au contact, since the SPP exists at the longer wavelength side from 620.7nm [1], it is considered that reduction of this reflectance is caused of excitation of the SPP. Therefore, in GaP-Au contact, it became clear that the SPP can be generated by irradiating with light from the GaP side. When Au film thickness was 30 nm or 50 nm, reflectance reduced most sharply at the SPP resonant angle. In case of 30 nm, the reflectance becomes minimum value at this angle. When Au film thickness was 10 nm, the reflectance at the SPP resonant angle hardly reduced. From these results, the 30-nm-thick Au film is most effective for the system of GaP/Au/$H_2O$ and GaP/Au/$C_2H_5OH$.

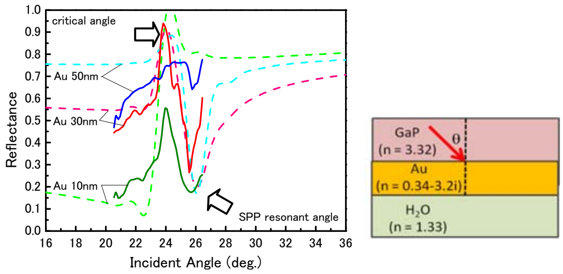


Fig.1 The simulation (broken line) and experimental (solid line) result of the reflectance depending on the incident angle in case of GaP/Au/$H_2O$.

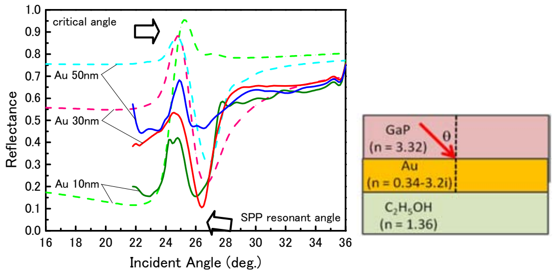


Fig.2 The simulation (broken line) and experimental (solid line) result of the reflectance depending on the incident angle in case of GaP/Au/$C_2H_5OH$.

In summary, in order to apply the Au-GaP contacts to the SPP chemical sensors for high refractive index, the reflectance depending on the thickness of Au is examined. From the reflectance measurement in the case of $H_2O$, and $C_2H_5OH$, the degrees which are corresponding to the excitation of the SPP are found and that are consistent with simulation data. Therefore, it is considered that the GaP-Au contact is useful for the excitation of the SPP and the application to chemical sensors.

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**References**

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