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Spectra of emission light from Ag/ Rhodamine-B (RB) LB films due to surface plasmon (SP) excitations have been investigated using an attenuated total reflection (ATR) method and a reversed ATR (R-ATR) method. In the R-ATR configuration, emission light was observed through the prism, and the intensities and spectra strongly depended upon the emission angle where the light was observed. The relation between the wavelengths and the emission angles agreed with the resonant conditions of excitations of SPs in the ATR configuration. It was concluded that the emission light was caused by excitations of multiple SPs.

Key words: Surface plasmon; Rhodamine-B LB films; ATR method; R-ATR method; Emisson light

INTRODUCTION

Surface plasmon resonant (SPR) methods have attracted much

attention, since surface plasmons (SP) resonantly excited at metal surfaces are strongly influenced by conditions of the surfaces [1]. Attenuated total reflection (ATR) measurements utilizing SP excitations are used to evaluate structure and optical properties of organic ultrathin films on metal thin films and as one of sensing methods [2]-[4].

Recently, emission light was observed at a resonant angle region of SP excitations through the prism in the Kretschmann configuration of the ATR measurements when metal thin films on the prism or organic thin films on the metal thin films were directly irradiated from air by a laser beam, that is, in the reversed-ATR (R-ATR) method [5]-[7]. But this phenomenon is not clarified yet.

In this study, emission light properties have been investigated for rhodamine-B (RB) LB films on silver films using the R-ATR method of the Kreschmann configuration.

EXPERIMENTAL DETAILS

Figure 1 shows the chemical structure of RB used in this study. RB is well known as a laser dye molecule. The RB molecules were mixed with arachidic acid (C20) for good depositions and the molar ratio of the mixture was [RB]: [C20]=1:5. RB LB films with ten monolayers were deposited on microscopic cover glass with evaporated Ag films of about 50nm thick.

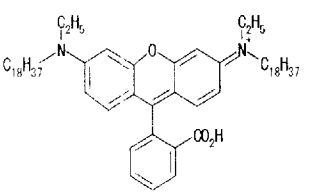

Figure 1 The chemical structure of RB.

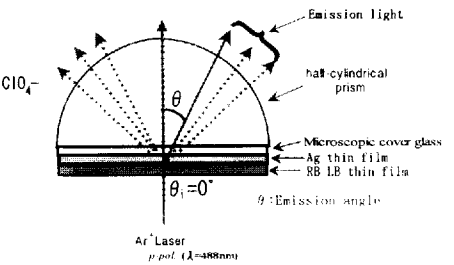

Figure 2 A sample configuration for the R-ATR measurement and emission light.

Figure 2 shows the sample configuration for the R-ATR measurement. The Ag/RB LB film on the cover glass was attached to the bottom of a half-cylindrical prism using a matching oil. A p-polarized Ar^+ laser beam at 488nm was irradiated vertically, θ_i=0°, to the sample surface in the R-ATR measurements. Intensities and spectra of the emission light through the prism are measured as a function of the emission angle, θ.

RESULTS AND DISCUSSION

The R-ATR Property

Figure 3 shows the emission light as a function of the emission angle for the Ag/RB LB film in the R-ATR method. The maximum intensity of the emission light was observed at 54° and the emission light was broad around the peak. This peak angle corresponded with the SP resonant angle at the dip in the ATR property in the inset of Fig.3. The result exhibited that the emission light was related to the SP resonant excitation. It was thought that the emission light was also due to some surface roughness and lack of uniformity of the films, because SPs can not be excited if the silver and the RB LB films are perfectly flat and uniform.

Emission Light Spectra from the Ag/RB LB Film

Figure 4 shows spectra of the emission light from the Ag/RB LB film at various emission angles in the R-ATR method. The spectra varied with the emission angles. The peak wavelengths of the emission light became shorter as the angles increased. The spectrum of the peak of 54° had no emission between 530 and 730nm, but the peak was due to the incident laser beam at 488nm. Each spectrum in Fig.4 was included in some part of the whole photoluminescence spectrum of the RB LB films. The relation between the peak wavelengths and the emission angles agreed with the dispersion property of the SP resonant excitations. It was concluded that the emission light was caused by simultaneous excitations of multiple SPs.

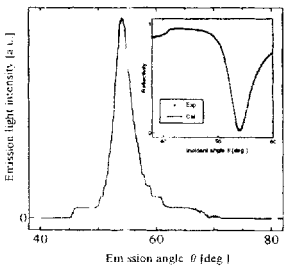

FIGURE 3 An R-ATR property of Ag/RB LB film with 10 monolayers and the ATR property in the inset.

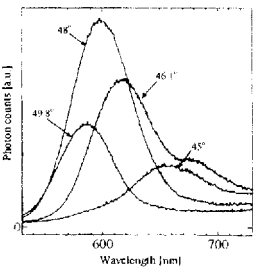

FIGURE 4 Spectra of the emission light from the Ag/RB film at various emission angles.

CONCLUSION

The emission light through the prism was observed in the configuration of prism/Ag/RB LB film using the R-ATR method. The peak wavelengths of the emission light varied with the emission angles. The relation between the peak wavelengths and the emission angles agreed with the resonant conditions of the SP excitations in the ATR configuration. It was concluded that the emission light was caused by simultaneous excitations of multiple SPs.

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