Extended Abstracts of the 2004 International Conference on Solid State Devices and Materials, Tokyo, 2004, pp. 854-855

F-8-4

Structure and Properties of Aluminum Phtalocyanine Chloride Thin Films Due to Vapor Treatments

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1. Introduction

Phthalocyanine dyes have been attracting much interest for developing many kinds of electronic devices. Many studies using phtalocyanine dyes have been reported for organic solar cells, field effect transistors, organic light emitting diodes, gas sensors, secondary batteries, etc. The optical and electrical properties of phthalocyanines depend on the molecular stacking. It is known that structure of molecular stacking of aluminum phthalocyanine chloride (AlClPc) can be induced with some organic vapors [1].

In this study, AlClPc thin films were fabricated using a vacuum evaporation method and the structure and properties were investigated before and after vapor treatments. The structure and properties were examined by the measurements of optical absorption, AFM, attenuated total reflection (ATR) and emitted light due to surface plasmon (SP) excitations [2-4].

2. Experimental Details

Figure 1 shows the chemical structure of AlClPc molecule used in this work. AlClPc thin films were fabricated by a vacuum evaporation method and the structure and properties were investigated due to vapor treatments of ethanol and H_2O.

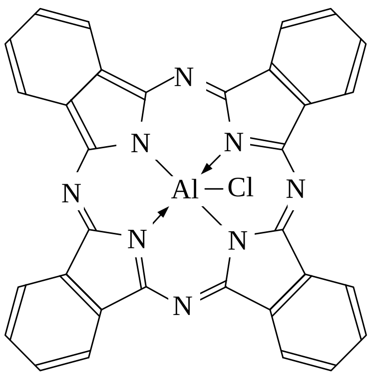


Fig.1. Chemical structure of AlClPc molecule.

UV-visible absorption spectra were measured for the as-deposited and vapor-treated AlClPc thin films with the thickness of about 20 nm on glass substrates.

The ATR properties in the Kretschmann configuration of prism/Ag/AlClPc structure were measured. The emitted light due to SP excitation in the ATR Kretschmann configuration by means of reverse irradiation of a laser beam [2-4] was also measured. For the measurements of the ATR and emitted light, AlClPc thin films with the thickness of 10 nm were evaporated on Ag thin films.

3. Results and Discussion

The UV-visible absorption spectra of the as-deposited film and the film treated with ethanol vapor for 10 min were shown in Fig. 2. The spectra contain the Soret and Q bands. It was found that the peak in the Q band of the film treated with ethanol vapor appeared at lower wavelength than that of the as-deposited film. After the treatment with H_2O of the ethanol-vapor-treated film, a new peak was also observed at around 800 nm.

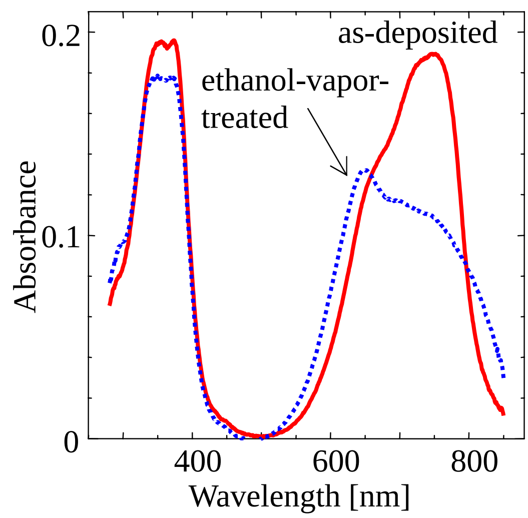
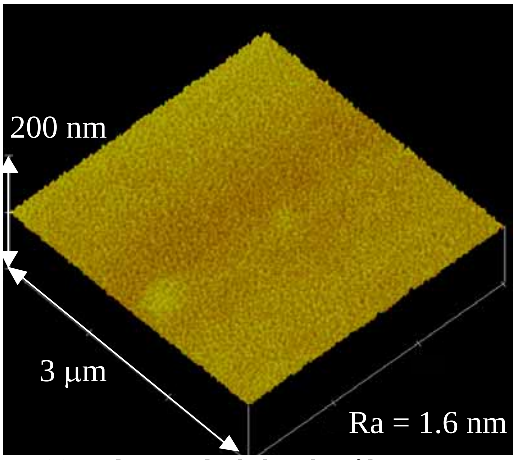
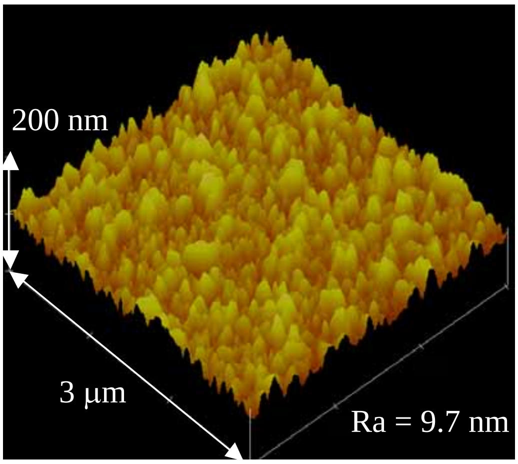


Fig. 2. Optical absorption spectra of as-deposited AlClPc thin film and the film treated with ethanol vapor for 10 min.

Figures 3 (a) and (b) show the AFM images of the as-deposited AlClPc thin film on Ag thin film and the film treated with ethanol vapor for 10 min, respectively. The surface roughness is found to increase markedly with ethanol-vapor treatment. The increase of the surface roughness was also observed due to H_2O vapor treatment. The surface roughness of the film treated with H_2O vapour was smaller than that treated with ethanol vapor.



(a) as-deposited AlClPc thin film on Ag



(b) ethanol-vapor-treated AlClPc thin film on Ag

Fig. 3. AFM images of AlClPc thin films on Ag thin films before and after the treatment with ethanol vapor.

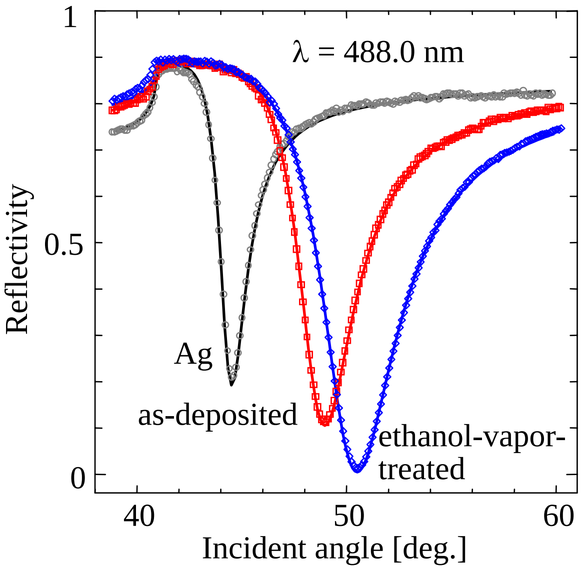


Fig. 4. ATR properties measured at 488.0 nm for Ag thin film, as-deposited AlClPc thin film on the Ag thin film and the film treated with ethanol vapor for 10 min.

Figure 4 shows the ATR properties measured at 488.0 nm for Ag thin film, as-deposited AlClPc thin film on the Ag thin film and the film treated with ethanol vapor for 10 min. It was found that the thickness evaluated from the theoretical calculations increases with the treatment of ethanol vapor. From the ATR properties due to H_2O vapor treatment, the evaluated thickness was also found to increase.

The emitted light from prism/Ag/AlClPc film is shown in Fig. 5. The curves are observed using the incident laser beam with wavelength of 488.0 nm. The peak angles of the emitted light curves correspond to resonant angles of ATR curves in Fig. 4, which suggests that the emitted lights were due to SP excitation. Furthermore, the intense emitted light was observed for the AlClPc thin film treated with ethanol vapor. It was considered to be caused by the large surface roughness of the AlClPc thin film due to the treatment with ethanol vapor. It was also observed for the film treated with H_2O vapor.

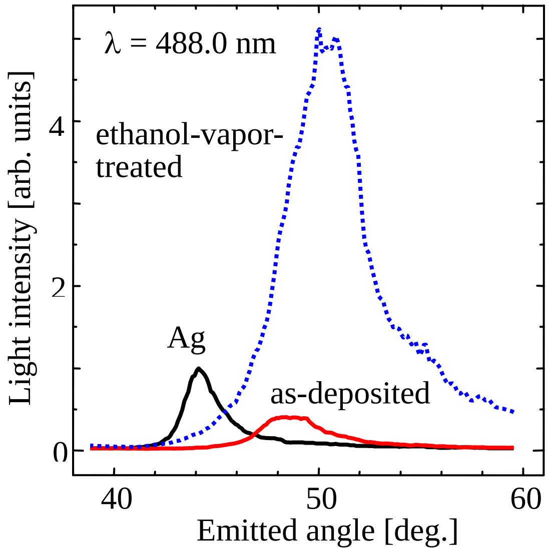


Fig. 5. Emitted light of Ag thin film, as-deposited AlClPc thin film on the Ag thin film and the film treated with ethanol vapor for 10 min.

4. Conclusions

AlClPc thin films were prepared and the structure and properties were investigated. It was found that the structure and properties were considerably changed by the treatments with ethanol and H_2O vapors. The results in this work are useful for the development of sensing devices.

References

[1] Y. Sakakibara, R. N. Bera, T. Mizutani, K. Ishida, M. Tokumoto and T. Tani: J. Phys. Chem. B 105 (2001) 1547.
[2] K. Kato, M. Terakado, K. Shinbo, F. Kaneko and T. Wakamatsu: Thin Solid Films, 393 (2001) 97.
[3] T. Nakano, M. Terakado, K. Shinbo, K. Kato, F. Kaneko, T. Kawakami and T. Wakamatsu: Jpn. J. Appl. Phys. 41 (2002) 2774.
[4] F. Kaneko, T. Sato, M. Terakado, T. Nakano, K. Shinbo, K. Kato, N. Tsuboi, T. Wakamatsu, R. C. Advincula: Jpn. J. Appl. Phys. 42 (2003) 2511.