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大気圧プラズマによるヘキシルアミンモノマー重合における プラズマガス種の影響

Effect of plasma gas species on atmospheric pressure polymerization of Hexylamine monomer

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In recent years, as electrical equipment has become smaller and lighter, it is often required to take measures to cope with increased thermal and mechanical stress inside the equipment. For example, in the case of high-voltage devices such as power devices and switchgear, the high-voltage components are electrically insulated by molding them with resin material. As the stress inside equipment increases, delamination occurs at the interface between the high-voltage components and the insulation resins, causing damage to the equipment. In general, as a method to prevent delamination, it is known that surface modification such as silane coupling treatment is used to increase the compatibility with the resin. However, this method requires a cleaning process using organic solvents and high-temperature treatment such as drying and curing, which have a large environmental impact. Therefore, we focused on a surface modification technique using chemical vapor deposition (CVD) with atmospheric pressure plasma. In this technique, a mist of precursor is injected with a plasma jet flow to form a thin film on the substrate surface. The advantage of this method is that it does not require cleaning and drying processes. In addition, many types of chemicals can be used as a precursor, and thin films with various properties can be formed. However, deposition process is complex because active species generated by the plasma strongly affect the chemical reactions. Therefore, in this study, we investigated the effects of parameters such as plasma gas species on the deposition process.

We used plasma jet type device for plasma CVD. Hexylamine was used as the precursor, and He, N_2 or He with small amount of N_2 were used as the plasma generating gases. Hexylamine was misted by bubbling and introduced into the plasma jet flow. The deposition rate was measured by the Quartz Crystal Microbalance method (QCM) and the chemical structure of thin films deposited by plasma CVD was characterized by Fourier transform infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS). The deposition rate was measured by varying the distance between the QCM sensor and the plasma jet. As shown in Fig. 1, deposition behavior differed significantly depending on the plasma generating gas species. When He was used as the plasma generating gas, the deposition rate increased as the distance between the sensor and the device decreased. A similar tendency was observed when a small amount of N_2 was added to He. On the other hand, in the case of N2, the deposition rate decreased when the distance between the sensor and the device was closer than 10 mm. In this presentation, we will report on the effects of deposition parameters such as plasma gas and other parameters on deposition rate and chemical composition and structure.

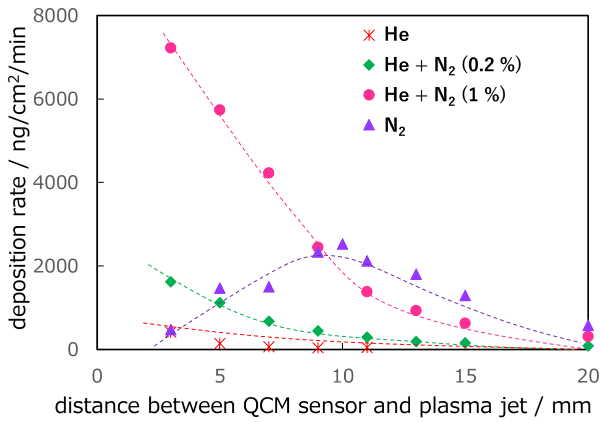

Fig.1 The relationship between plasma gas species and deposition rate measured by QCM.