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Development of High-performance Purfluorinated Polymer Electret

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I. INTRODUCTION

Recently, micro power generation using electret-based electrostatic induction attracts much attention due to its large power output at low frequency range [1, 2]. Since theoretical power output is proportional to the square of the surface charge density of electret, development of high-performance electret is required. Boland et al. [1] employed Teflon® AF (Du Pont) as their electret film. We previously found that perfluorinated polymer CYTOP™ CTL-M (Asahi Glass Co., Ltd.) shows high surface charge density of 1.3 mC/m^2 (at the thickness of 16 μm), which is 3 times larger than that of Teflon AF [2]. This paper presents a new high-performance polymer electret with higher surface charge density, stability, and high thermal resistibility of electric charges.

II. HIGH PREFORMANCE POLYMER ELECTRET

A. High Surface Charge DensityPolymer Electret

Figure 1 shows the molecular structure of CYTOP. There are three different types of commercial grade CYTOP depending upon their end group, i.e., trifluoromethyl (CTL-S), carboxyl (CTL-A), and amidosilyl (CTL-M). Corona discharge is employed for the charging, and a series of measurements of surface potential was made.

We found that the functional end group, especially amidosilyl in CTL-M, significantly enhances the surface charge density of CYTOP. Thus, we doped aminosilane into the CTL-A to increase the concentration of amidosilyl functional group. Figure 2 shows the surface charge density of 15 μm-thick electret film for different concentration of aminosilane. By doping only 0.6-3.0% of aminosilane into CTL-A, the surface charge density has been doubled; surface charge density as high as 1.5 mC/m^2 has been achieved, and it remains constant over 4000 hours.

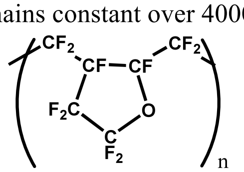

Fig. 1. The molecular structure and the end groups of CYTOP.

B. Thermal Property of Aminosilane-doped Perfluoropolymer

Figure 3 shows the TSD spectra of aminosilane-doped CTL-A in comparison with that of CTL-A and CTL-M. The peak temperature of TSD spectra of aminosilane-doped CTL-A is shifted to much higher temperature of 184°C.

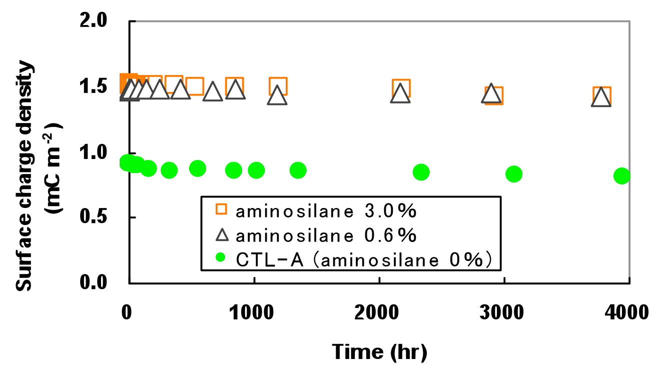

Fig. 2. Time trace of the surface charge density of aminosilane-doped CYTOP (aminosilane 0.6 wt%, and 3.0 wt% ; film thickness:15μm)

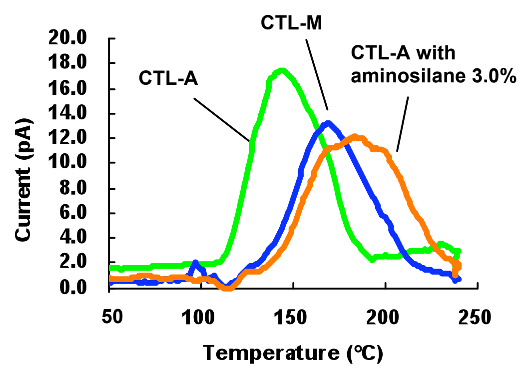

Fig. 3. TSD spectra of CTL-A, CTL-M, and aminosilane-doped CYTOP (aminosilane 3.0 wt% ; film thickness:15μm)

In summary, both surface charge density and thermal stability are improved by doping of aminosilane into CYTOP. The charge density of 1.5 mC/cm^2, which is 3.5 times larger than that of Teflon AF, has been obtained on 15 μm-thick film.

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REFERENCES

[1] J. Boland, C.-H. Chao, Y. Suzuki, and Y.-C. Tai, *Proc. 16th IEEE Int. Conf. MEMS, Kyoto*, pp.538-541, 2003.

[2] T. Tsutsumino, Y. Suzuki, N. Kasagi, and Y. Sakane, *Proc. 19th IEEE Int. Conf. MEMS, Istanbul*, pp. 98-101, 2006.