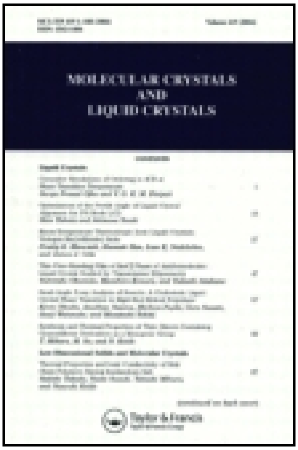

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Electrical Property of a Layered Non-Centrosymmetric Self-Assembly Based on Barbituric Acid and Melamine Derivatives

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Electrical Property of a Layered Non-Centrosymmetric Self-Assembly Based on Barbituric Acid and Melamine Derivatives

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Electrical property of a layered non-centrosymmetric self-assembly $PB_{12} \bullet M_{12}$ was studied. The assembly was fabricated by hydrogen bonding interaction of 5-(4-dodecyloxy benzylidene)-2,4,6-(1H,3H)-pyrimi-dinetrione (PB_{12}) and 4-amino-2,6-didodecylamine-1,3,5-triazine (M_{12}). The result shows that the assembly has a good electrical insulation ability.

Keywords: electrical property; self-assembly; barbituric acid; melamine

INTRODUCTION

Non-centrosymmetric organic crystals formed by supramolecular self-assembling are getting more and more important, due to their potential applications in functional materials, such as microelectronic devices and high-density information storage materials[1]. It appears that self-assemblies constructed through hydrogen bonds are superior in many properties to those through other non-covalent interactions, since hydrogen bonds are able to cause a stronger interaction between molecules and provide the assemblies with a better orientation ability of molecules[2-6]. One of typical examples is the assemblies composed of barbituric acid and melamine derivatives, which bear complementary hydrogen bond groups. There have been a number of reports concerning this kind of assemblies in its assembling processes and structure analysis[7-9]. However, their electrical properties have not been investigated yet. In this work, we represent the capacitance-voltage (*C-V*) feature of a layered non-centrosymmetric self-assembly $PB_{12}M_{12}$, which is constructed by 5-(4-dodecyloxy benzylidene)-2,4,6-(1H,3H)-pyrimi-dinetrione (PB_{12}) and 4-amino-2,6-didodecylamine-1,3,5-triazine (M_{12}). Their molecular structures are shown in Figure 1.

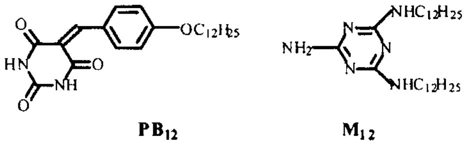

FIGURE 1. Molecular structures of PB_{12} and M_{12}

EXPERIMENTAL

PB_{12} and M_{12} were synthesized in our laboratry[10]. Chloroform was purchased from Tianjin Chemicals Factory and treated by refluxing it overnight by the presence of P_2O_5 under argon.

PB_{12} and M_{12} were assembled according to a method reported in detail elsewhere[7]. For *C-V* measurement, a chloroform suspension of the solid assembly was spread on a n-type silicon wafer with a thin layer of silica. After chloroform was evaporated, an aluminum dot as top electrode was coated on the surface of the assembly by vacuum deposition technique to achieve a device Al/$PB_{12}M_{12}$/n-silicon. For comparison, Al/SiO_2/n-silicon was also built up, where the SiO_2 layer is from the n-silicon surface. *C-V* curves for the two devices were recorded on a PAR MODEL 410 C-V plotter at 1 MHz with the scanning rates of 5 mV/s and 10 mV/s.

RESULTS AND DISCUSSION

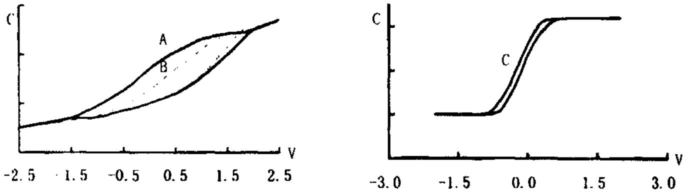

FIGURE 2. *C-V* curves of $PB_{12}M_{12}$ assembly (scanning rate of A: 5 mV/s, B: 10 mV/s) and silica for comparison (scanning rate of C: 5 mV/s)

Figure 2 shows the *C-V* measurement results of the devices with $PB_{12}M_{12}$ and silica layer. Curves A and B represent changes in capacitance of $PB_{12}M_{12}$ with bias at scanning rates of 5 mV/s and 10 mV/s, and curve C corresponds a change in capacitance of silica layer with bias at 5 mV/s. By comparison, it is found that there is a larger shift in *C-V* curves A and B than in curve C, that is, $PB_{12}M_{12}$ leads to a larger hysteresis than the silica layer does. With the increase in the scanning rate from 5 mV/s to 10 mV/s, the hysteresis caused by $PB_{12}M_{12}$ becomes weaker.

A possible explanation for the hysteresis can be assigned to the retaining of electrons in the silica layer and $PB_{12}M_{12}$ assembly. Under an applied field, electrons are capable of injecting into the SiO_2 layer in device Al/SiO_2/n-Si and into the assembly $PB_{12}M_{12}$ and also the silica layer in the device Al/$PB_{12}M_{12}$/n-silicon. Furthermore, much more electrons are retained in the assembly. Then a built-in electronic field E' is set up which opposes the applied field E. This means that the assembly $PB_{12}M_{12}$ is a better insulator than silica. Therefore, the device Al/$PB_{12}M_{12}$/n-silicon can be thought of as a typical metal-insulator-semiconductor [MIS] structure, and

Al/SiO$_2$/n-silicon just as a typical metal/oxide/semiconductor [MOS] structure.

Additionally, the magnitude of the hysteresis for PB$_{12}$M$_{12}$ directly changes with scanning rate. The slower the scanning rate is, the larger the hysteresis is. This could be attributed to the position of electrons in the layered assembly. At a lower scanning speed the electrons can be located in the deeper layer of the assembly and a stronger built-in field is set up, so a lager hysteresis can be observed. Therefore, the hysteresis in curve A is larger than one in curve B, which were achieved at 5 mV/s and 10 mV/s, respectively. The result shows that the assembly might be used in functional materials, and more detailed studies on this system are now in progress.

Acknowledgments

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