Preparation and Properties of PVDF Multilayer Film

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ABSTRACT

As the rapid development of the electronics, the demand for portable electronics and wireless sensors is growing faster, also with the increased needs of one material which can power it automatically, and then power the electrical devices. The piezoelectric effect of the PVDF material can be used for this. So in this paper, PVDF multilayer films were made for this aim. Make the PVDF / DMAc solution in the 10% concentration; use the spin coater technique to make films with the optimum process parameters: the spin rate is 1260rpm; the spin time is 70s; the dry temperature is 100℃; the dry time is 30mins. And also, for obtaining the higher ß-phase crystallinity, put the Ca(NH3)2.4H2O into the PVDF / DMAc solution system..

Key words: ß-phase, crystalline structure, spin coater, poly (vinylidene fluoride)

1. INTRODUCTION

As the rapid development of the electronics, the demand for portable electronics and wireless sensors is growing faster. Nowadays, many devices use the battery as the electric source. But the power consumption is a critical concern of many electrical devices used in diversified applications. And for the portable property, the big size and the finite lifetime of the battery also become the key problem. So there needs something to replace the battery, the key to replace the finite power supplies is the ability to capture the ambient energy surrounding the electronics. That means a material which can be powered itself, and then power other energy devices. PVDF is one material for this usage because its excellent piezoelectric effect. In this experiment, for gaining the higher piezoelectricity, it was tried to make the PVDF multilayer films. The multilayer films contain only PVDF without other material. The films are made and the properties are checked. Also the other PVDF films were made by putting the Ca(NH3)2.4H2O into the solution.

2. EXPERIMENT

In this experiment, the materials were as follows, Poly (vinylidene fluoride) (PVDF), with the parameters: Mw is 275.000; melt viscosity is 17,500.000—21,500.000 poise (100 sec-1, 230 ℃). The solvent is N, N-dimethylacetamide (DMAC), and the Calcium nitrate tetrahydrate: Ca(NH3)2.4H2O.The PVDF solutions were made with the concentrations of 10%, 13%, 15%, 20%, and 25% respectively at the temperature of 30 ℃. In this experiment using the spin coater to make the multilayer films. The procedure is: fist, made a single PVDF film with the best parameters of the highest ß-phase, and then putted it into the oven for drying. After that putted the finished film on the spin coater wafer again as the substrate, putted the same solution onto it and spanned for the 2-layers PVDF film. The process parameters were all the same. And be dried again. All the multilayer films were produced by this way. In this experiment, according to the theory, made five films, they were from 1-layer film to 5-layers film respectively. The spin time was 70s; the spin rate was 1260 rpm, the dry temperature was 100 ℃, the dry time was 30 mins.

The surface and cross-section morphology of PVDF multilayer films were observed using SEM. The melting point and total crystallinity of PVDF multilayer films were characterized by DSC. The heat rate was set to 10 ℃/min. The crystal structure was checked by FT-IR, the ą-phase and b-phase were associated with the vibration band peaks at 530, 766cm-1 and at 510, 840 cm-1 respectively.

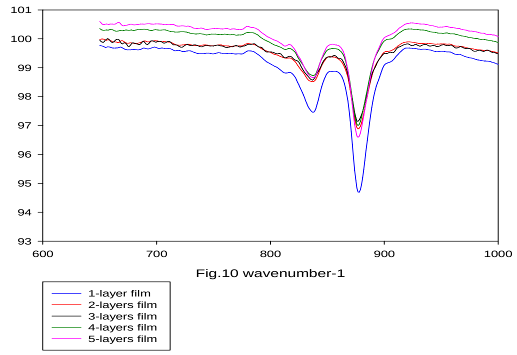

Fig.1 FT-IR spectrum of five films

3.RESULTS AND DISCUSSION

As the Fig.1 the multilayer films have nearly the same content of ß-phase, they are not increasing with the layer number increases. Also as the Fig.2 shows, the surface and cross-section morphology were nearly the same of the 5 films. That because the new solution will solutes the substrate film immediately. So there don't show the multilayer-like cross-section. The multilayer films seem won't have the great differences. And using the DSC, we can calculate the total crystllinity of the PVDF films. According to the result, the PVDF films made without the Ca(NH3)2.4H2O obtained the maximum crystallinity of 15%, but with the Ca(NH3)2.4H2O in the solution ,it can obtain the 27% crystallinity. That is because the existence of some intermolecular interactions.

4. CONCLUSION

In the experiment, using spin coater to make PVDF multilayer films, the highest ß-phase is obtained by the parameters which are as follows: the solution concentration is 10%, the spin time is 70s, the spin rate is 1260 rpm,
dry temperature is 100 ℃, the dry time is 30 mins. But there are very little differences between the multilayer films. And with the Ca(NH3)2.4H2O in the solution, it can obtain more crystallinity.

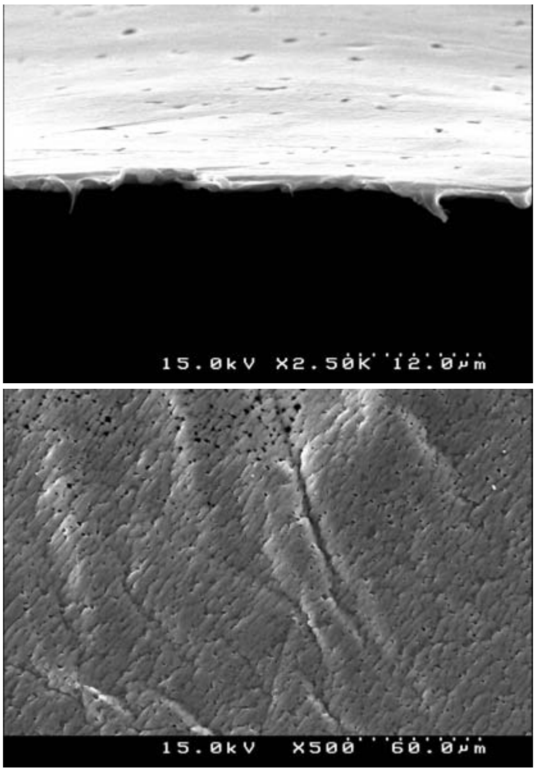

Fig.2 the SEM of 3-layers PVDF film

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