Toughnening of Dielectric Material by Thermoplastic Polymer

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Recently, high performance microelectronic devices are designed in multi-layer structure in order to make dense wiring of metal conductors in compact size. Imprint lithography have received significant attention due to an alternative technology for photolithography on such devices. In this work, we synthesized dielectric composite materials based on epoxy resin, and investigated their thermal stabilities and dynamic mechanical properties for thermal imprint lithography. In order to enhance the mechanical properties and toughness of dielectric material, various modified polyetherimide(PEI) was applied in the resin system.

Curing behaviours, thermal stabilities, and dynamic mechanical properties of the dielectric materials cured with various conditions were studied using dynamic differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), and Universal Test Method (INSTRON).

Key word: Epoxy resin, thermoplastic polymer, Polyetherimide, toughness, Imprint

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Normally, PEI synthesized in NMP (1-methyl 2-pyrrolidinone) solvent system. However, NMP has very high boiling temperature and low vapor pressure, therefore, the NMP remains in dielectric material after the imprinting process and cause decimating physical characteristics. In this study, PEI precursor is synthesized with 2-methoxy ethanol solvent in order to match the main solvent of resin system and prevent phase separation. FT-IR analysis shows that synthesized PEI precursor has carbonyl groups are able to be converted imide groups.

The PEI precursor added and blended in epoxy resin system. This addition of PEI precursor result in a dramatic enhance of modulus of dielectric material because the carbonyl functional group is changed into imide group through condensation reaction between carbonyl units and amide units, subsequently, form strong crosslinks with epoxy resin.

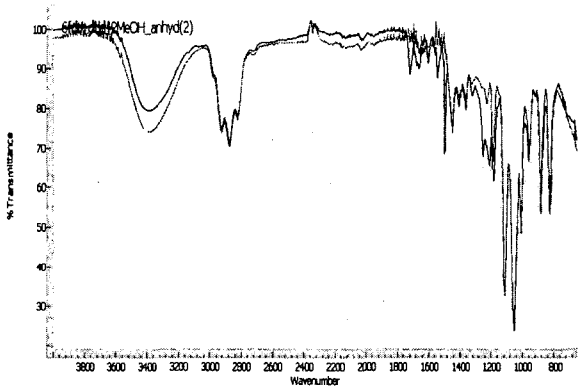

Fig. 1. FT-IR spectra of PEI precursor and 2-methoy ethanol. The blue bends at 1600~1800 cm^{-1} indicate that PEI precursor synthesized base on 2-Methoxy ethanol solvent has carbonyl group.

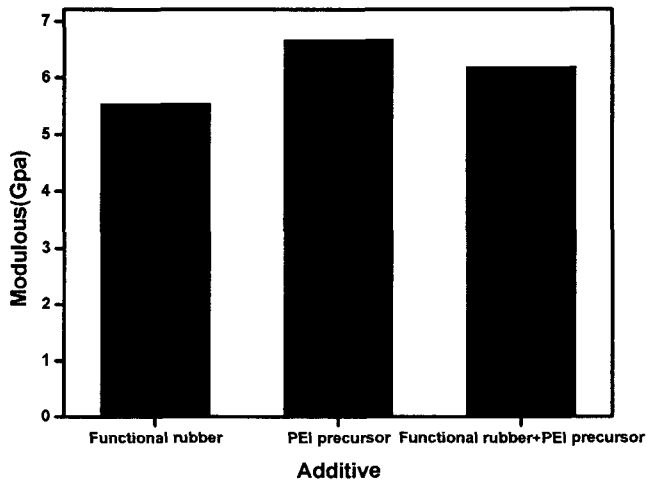

Fig. 2. Modulus of dielectric materials with various additives

References

1. Jyongsil Jang, and Seunghan Shin, Polymer, 36, 1199 (1995)
2. Sridhar K. Siddhamalli, Polym.-Plast.Technol.Eng., 39, 699 (2000)
3. Jyong-Sup Shim, Ho-Soon Jung and Jyong-Sik Jang, J. of Korean Ind. & Eng. Chemistry, 1, 124 (1990)
4. L. Barrl, J. Cano, J. Lopez, I. Lopez-Bueno, P. Nogueira, A.Torres, C. Ramirez, M.J. Abad, Thermochim. Acta., 344, 127 (2000)
5. D.H. Kim, S.C. Kim, Poly Bull., 18, 533 (1987)
6. L. Barrl, J. Cano, J. Lopez, P. Nogueira, C. Ramirez, J. Appl. Poym. Sci., 63, 1841 (1997)