

Synthesis and Property of SiO₂-Polyetherimide – Bismaleimide Hybrid Composites

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Introduction:

Sol-gel reactions have been extensively studied for over two decades as a method to prepare ceramic precursors and inorganic glass at relatively low temperatures. In the past 10 years, many organic-inorganic hybrids such as PMMA-SiO₂, PI-SiO₂, PVP-SiO₂ were produced by this technology.^[1,3,4]

Bismaleimide (BMI) resins as high-performance thermosetting resins have been widely used as matrices for advanced composites. However, the BMI resins are extremely brittle because of their highly crosslinked structure. Various attempts have been made to improve the impact and fracture toughness of BMI resin. In our previous works, one excellent modification is the use of polyetherimide (PEI) to enhance the fracture toughness of the BMI resins.^[2]

In the present work, we use sol-gel technology to produce the hybrids of BMI-PEI-SiO₂. This is the first time to introduce SiO₂ into a two-components polymer system for further improving properties.

Experimental:

1. Preparation of BMI-PEI-SiO₂ hybrid

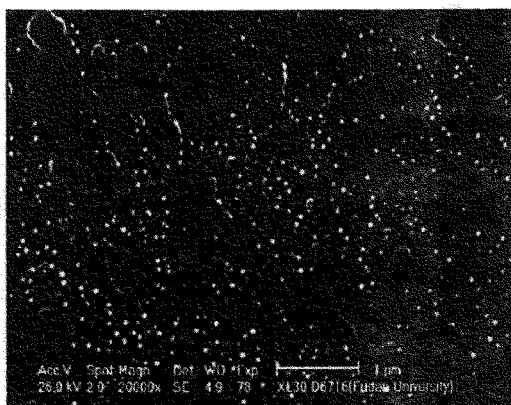
Bisphenol A dianhydride (BISA-DA), 4,4'-oxydianiline (ODA) were dissolved in DMAC to make PAA, then tetraethoxysilane (TEOS) and distilled water (4/1 based on moles of TEOS), were added into the solution. After 6h, BMI (contain two components: bis(4-maleimidediphenyl) (BDM) and O,O'-diallyl bisphenol A (DBA) was added into the solution and stirred for another 6h. Then the solution was casted on aluminum foil and dried for 48h. The film was cured at 180 °C for 2h, and 200 °C for 4h.

2. Analysis and Characterization

The hybrid was characterized by Scanning electronic microscope (SEM) and thermal gravimetric analysis (TGA).

Result and discussion:

The morphology of the hybrid was showed below :



SEM result displays that the modified system shows both the BMI-rich phase and the PEI-rich phase form the continuous structure, and silica dispersed in the PEI-rich matrix of the hybrid uniformly. The size of the silica particles is about 40nm. Compared with reported PAA/SiO₂ system , the silica particles in our system is quite small . The hybrid is transparent with the silica content extended to 20phr.

The TGA data was showed below:

SiO ₂ content (phr)*	0	10	15	20
T _d (5%decomposed) °C	382.2	394.4	403.7	418.3
T _r (40%decomposed) °C	525	530	540	570

*phr of SiO₂ is compared with BMI(calculated as 100 phr)

The hybrid showed excellent thermal stability. The T_d of the hybrid increased with the content of silica. For the hybrid contain 20phr silica, it lost 40% weight when heated to 570 °C, and even 40% weight remained at 800 °C. The increase in the thermal stability may resulted from the high thermal stability of silica and the continuous structures of polymer matrix.

In summary, BMI-PEI-SiO₂ hybrid was prepared by sol-gel technology. Silica was dispersed uniformly in the hybrid. The hybrid showed excellent thermal stability. The measurements of Dynamic Mechanical Analysis and further study on this system is underway.

References:

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