

Investigation of Swelling, Mechanical and Recycling Properties of Heat-Repairing Material

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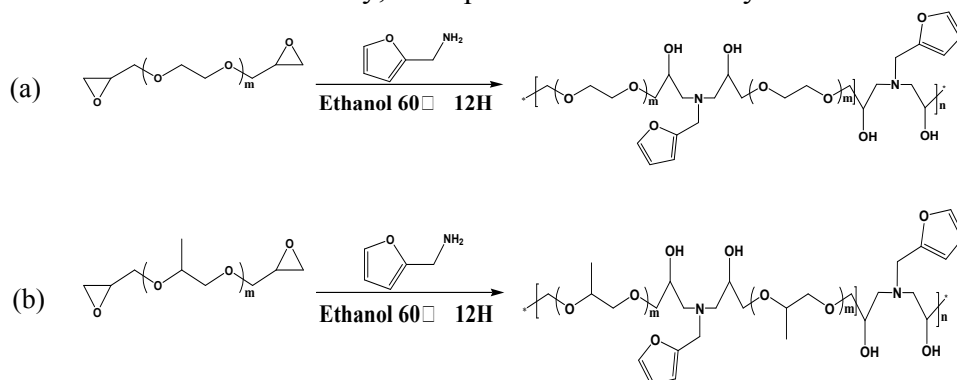
1. Experimental

1.1 Materials

Polyethylene glycol diglycidyl ether (PEGDGE, the epoxy value measured by hydrochloric acid-acetone solution was 0.3983) and polypropylene glycol diglycidyl ether (PPGDGE, the epoxy value measured by hydrochloric acid-acetone solution was 0.3125) were purchased from Shanghai Rufa Chemical Technology Co. LTD; furfurylamine (>99%) was supplied by Aladdin; N'-(4,4'-Diphenylmethane) bismaleimide (BMI, >98%) was supplied by Wuhan Zhihao Technology Co. LTD; N, N-dimethylformamide (DMF, >99%) and dichloromethane (DCM, >99.5%) were purchased from Tianjin Guangfu Fine Chemical Plant.

1.2 Synthesis of PEGFA and PPGDGE

PEGFA was synthesized by the addition reaction of furfurylamine and PEGDGE. The side group of PEGFA contains furan groups (FA). The specific method is as follows: PEGDGE was added into a round bottom flask and dissolved in the solvent of ethanol, furfurylamine was added dropwise. The reaction temperature was 60°C and the reaction time lasted for 12h. Removing the solvent by rotary evaporation and furfurylamine-PEGDGE could be obtained after dried in a vacuum oven. The equal molar ratio furfurylamine/PEGDGE was named PEGFA. PPGFA was synthesized by the addition reaction of furfurylamine and PPGDGE. The synthesis steps of PPGFA are the same as those of PEGFA. Similarly, the equal molar ratio furfurylamine/PPGDGE was named PPGFA.



Scheme S1 (a) Synthesis of PEGFA, (b) Synthesis of PPGFA.

1.3 Characterization

The influence of the main chain structure on the reversible properties of the material was

analyzed by the Differential scanning calorimetry (DSC, METTLER 821e) test. The effect of temperature on the reversible properties of material was studied by the Dynamic Thermomechanical Analysis (DMA, TA Q800). The frequency of the test was 1 Hz, the temperature range of heating was $-70\text{ }^{\circ}\text{C}\sim 150\text{ }^{\circ}\text{C}$ and the heating rate was $3^{\circ}\text{C}/\text{min}$. The mechanical property of the material was studied by the tensile testing machine (AG-I). The stretching rate of the test was $10\text{mm}/\text{min}$. The surface of tearing spline of material was observed by SEM (Inspect F50) with the acceleration voltage of 10kV and working distance of 8.7 mm .