





Shape memory epoxy resins and their composites with narrow transition temperature range

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## Outline





## 1 Background

Shape Memory Polymers (SMP) are polymeric smart materials that have the ability to recover from temporary shape to their permanent shape induced by an external

stimulus, such as temperature change.





## 1 Background

#### Shape Memory Epoxy Resin

**Shape memory epoxy resins (SMEP)** are one of the most widely used engineering intelligent polymers, mainly used in aerospace, intelligent bionics, and other fields of active deformation structures.





## 2 Design & Methods

#### **Experimental**



Different epoxy monomers and curing a gents are vibrated by uniform ultrasonic until the solution is transparent and unif orm.

Add different amounts of liquid epoxy t erminated nitrile rubber, melt it and sti r it with EP until it is uniform.

Add high–temperature latent curing ag ent, and repeat the above process for hi gh-temperature curing in turn.

Original Diamines 10phr System Triamines ETBN 15phr Tramines 20phr Epoxy DICY Toughening System 130°C Degassing Oven Vacuum oven 70°C Enhanced 180°C System Oven



## **3 Results**

#### Shape Memory Properties–DMA

- The storage modulus of glass state and rubber state changes by more than two orders of magnitude
- The glass transition temperature range is relatively narrow at about 20  $^\circ C$
- The benzene makes the molecular chain interact, the force between the chain segments is strong





## **3** Results

#### **Static Mechanical Properties**

- The molecular chain fluidity increases, the strength decreases, and the elongation increases
- Compared with rubber toughening, the strength after secondary curing is increased to 78MPa
- When the contentwas 10 phr, the elongation at break reached 11.7%





## **3** Results

#### **Static Mechanical Properties**

- The fracture morphology of pure epoxy resins were smooth planes
- The rubber phase gradually precipitates to form small balls dispersed in matrix, forming "seaisland structure"
- When the crack encounters rubber particles, the crack stops and micropores







### **Conclusions**

- A series of shape memory epoxy resins with narrow glass transition range (14–23 °C) were synthesized.
- Based on epoxy-terminated liquid nitrile rubber (ETBN) toughening and combining two-stage curing technology, the Tg, modulus and strength of the SMP were improved.





# **Thanks for Your Attention!**



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