

9.3 Thermosets

Principal commercial thermosets include epoxies, polyesters, and formaldehyde-based resins (i.e., phenol–formaldehyde, urea–formaldehyde, and melamine–formaldehyde). Typically, phenol resins constitute the largest segment of the thermoset market, followed by urea resins, unsaturated polyesters, and melamine resins.

9.3.1 Epoxies

Epoxies are formed by a two-stage process. Initially, a low-molecular-weight prepolymer is prepared by a base-catalyzed step-growth reaction of a dihydroxy compound such as bisphenol-A with an epoxide, typically epichlorohydrin, as illustrated in Figure 9-10. The prepolymer molecular weight is increased and the network is formed during a separate cure step, as shown in Figures 9-11 and 9-12. Amines, usually aromatic, may be used to cause ring opening of the end epoxide groups through nucleophilic addition (Figure 9-11). Carboxylic acid anhydrides such as phthalic acid anhydride can react with pendant hydroxyl to give ester acids, which can then react with epoxide or other hydroxyl groups to create additional ester groups (Figure 9-12). Epoxy resins have high chemical and corrosion resistance, outstanding adhesion properties, low shrinkage upon cure, and good electrical properties. Principal applications for these resins include protective coatings, composite matrices, and adhesives.

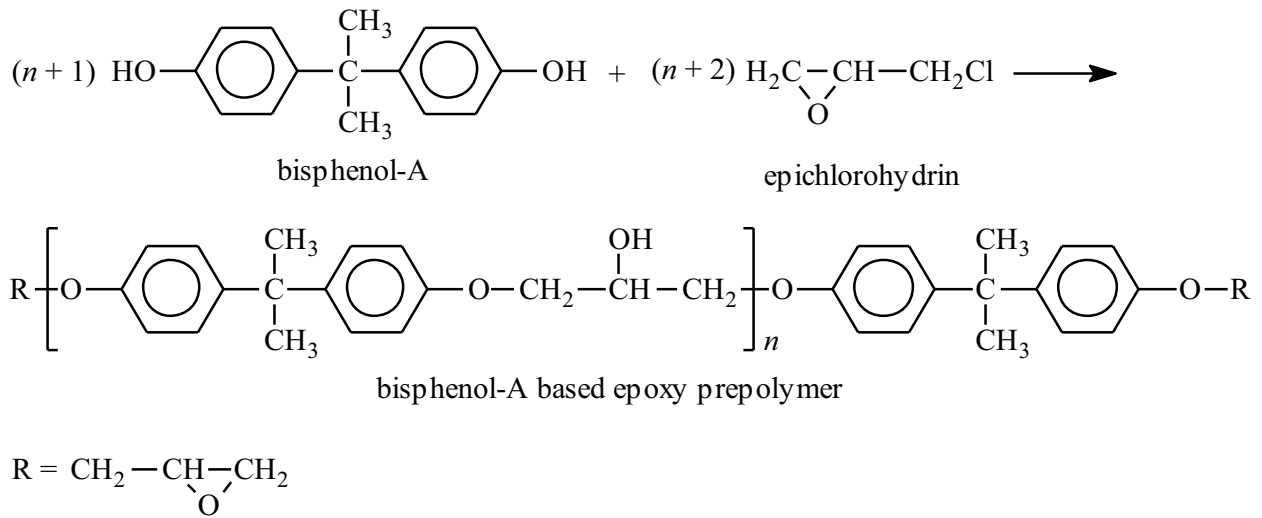


Figure 9-10 Epoxy prepolymer formed from bisphenol-A and epichlorohydrin.

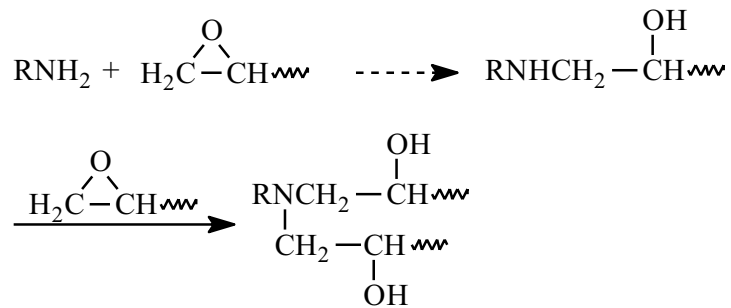


Figure 9-11 Cure of an epoxy resin by reaction of the prepolymer with an amine.