



Binary systems based on aromatic amines with a view of development of novel hardeners for epoxy resins

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Abstract

Three binary systems based on aromatic amines [4,4'-diaminodiphenylmethane (DDM), 4,4'-diaminodiphenyl sulfone (DDS), 4,4'-diaminodiphenyl ether (DDE) and *m*-phenylenediamine (MPDA)] were investigated by differential scanning calorimetry (DSC). Phase diagrams for different compositions were constructed. The DSC results showed that all binary systems form simple eutectic mixtures. Formation of eutectic physical mixture of MPDA–DDM and MPDA–DDS was confirmed by powder XRD study. In the case of DDE–DDS system, it was found that besides the eutectic mixture a small amount of the charge transfer complex forms with the novel crystal structure.

Keywords Aromatic amine · Phase diagram · DSC · Eutectic melting

Introduction

Development of new high-performance materials is one of the major challenges today. Because of their excellent properties such as thermal stability, strength, chemical resistance, very high adhesive properties, epoxy thermosetting materials are widely used as adhesives, coatings, compounds and matrices for composite materials [1, 2].

Depending on the type of curing agent and the curing conditions, it is possible to obtain materials with various mechanical properties and thermal stability and heat resistance. Curing agents such as diamines and anhydrides are useful in most of the important applications of epoxy resins. The use of anhydride hardeners in such compositions gives the materials with high physical and mechanical properties [3]. Aromatic diamines, being used as curing agents, increase thermal and chemical resistance of the

cured epoxy resin in comparison with the aliphatic diamines [4, 5], which allow to use epoxy/aromatic amine systems as matrices in high-performance fiber composites for aerospace applications.

Epoxy formulations based on aromatic amines such as 4,4'-diaminodiphenylmethane (DDM), 4,4'-diaminodiphenyl sulfone (DDS), *m*-phenylenediamine (MPDA) and *p*-phenylenediamine (PPDA) have been studied for decades [6–13]. However, high melting temperatures as well as low solubility in epoxides are still the main drawback of most of aromatic amines. Also there are some recent works focused on synthesis of novel aromatic amine curing agents [14–18]. Unfortunately, the significant reduction of curing temperature and improving of thermal properties of polymers has not been reached.

In the 1960s, there were several interesting attempts in development of hardeners based on eutectic mixtures of two or three aromatic amines [19–21]. However, only two mixtures (including MPDA–DDM) were suggested for commercial application without detailed and adequate substantiation of their composition. Thereafter, this idea has not received further expansion. Therefore, the aim of this study was the investigation of binary systems based on aromatic amines with attempt to develop eutectic mixtures capable to decrease curing temperature and improve heat resistance of obtained polymer materials.

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