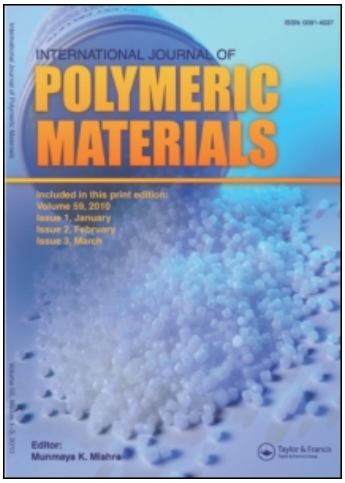

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Novel Epoxy Based Curing Agent for Coating Application

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Bis ester namely 1,1'-(1-methylethylidene) bis[4-{1-imino-4-ethyl benzoate-2-propanolyloxy}] benzene was synthesized by the reaction of epoxy resin, diglycidyl ether of bisphenol-A (DGEBA) and 4-amino ethyl benzoate (4-AEB) using triethylamine as catalyst. The synthesized bisester was reacted with two different aliphatic diamines viz., ethylene diamine (EDA) and propylene diamine (PDA) to obtain polyamide resins (PAs) designated as DGEBA-4-AEB:EDA and DGEBA-4-AEB:PDA respectively.

Using the synthesized polyamide as a curing agent and triethyl amine as a catalyst, DGEBA was polymerized on mild steel panel at 120 °C for 1 hr. The coated panels thus obtained were tested for scratch hardness, flexibility, impact strength and chemical resistancy.

Keywords: Polyamides; bisester; epoxy resin; chemical resistancy

INTRODUCTION

Epoxy resins have attained a prominent position in industry. In their fully cured state they have remarkable properties [1]. These properties, along with their low cost, made epoxy resin a potential substitute for phenolics in various important applications [2, 3]. Epoxy resin are no longer a novelty to the coating industry. Coatings based on epoxy resins are generally characterized by their excellent adhesion and overall chemical resistancy. They also exhibit a high degree of resistance to impact, abrasion and other types of physical abuse. It is therefore not surprising that epoxies have found utility in the end use areas like plant maintenance, automotive primers, can and drum coatings, pipe

coatings, appliance coatings, adhesives for home and industry, and military and aerospace usage etc [5].

Considering the above characteristics, it was thought desirable to explore the field of coating for the epoxy resin, DGEBA, using novel epoxy based polyamide as a curing agent. This communication is the extension of our earlier work on the synthetic aspect of this novel curing agent.

RESULTS AND DISCUSSION

The epoxy resin (DGEBA) and novel polyamides (curing agent) are soluble in common organic solvents such as methanol, acetone, dioxane etc.

The epoxy resin coated on the mild steel panels were cured thermally using novel epoxy based polyamides as a curing agent and triethylamine (1% by weight of resin) as a catalyst.

The novel epoxy based polyamides synthesized are DGEBA-4-AEB : EDA (a condensation product of diglycidyl ether of bisphenol-A-4-amino ethyl benzoate : ethylene diamine) and DGEBA-4-AEB : PDA (a condensation product of diglycidyl ether of bisphenol-A-4-amino ethyl benzoate : propylene diamine). The proportion of the resin and curing agent used are listed in Table I. The curing temperatures were decided from the evaluation of dynamic scans obtained from differential scanning calorimetry (DSC) [4].

TABLE I Flexibility, impact strength and scratch hardness of the coated panels

Resin System	*DGEBA PA Ratio*	*Flexibility*	*Impact Strength*	*Scratch hardness (gm)*
DGEBA : A	60 : 40	Pass	250	1600
DGEBA : A	70 : 30	Pass	260	1750
DGEBA : A	80 : 20	Pass	275	2000
DGEBA : B	60 : 40	Pass	225	1200
DGEBA : B	70 : 30	Pass	275	1375
DGEBA : B	80 : 20	Pass	300	1400

DGEBA : Diglycidyl ether of bisphenol-A.
A : DGEBA-4-AEB : EDA polyamide.
B : DGEBA-4-AEB : PDA polyamide.
4-AEB : 4-aminoethyl benzoate.

The results obtained for the scratch hardness, impact strength and flexibility test of the coated panels are presented in Table I.

The flexibility test was carried out on 1/4″ and 1/8″ conical mandrel, which confirm the good flexibility of the coated film. All the panels passed stripping test for adhesion. These might be due to free hydroxyl groups present in the resin system which contributed to the strong metallic bond formation with the surface of the mild steel panels. The good adhesion of the film may also be due to polyamide characteristics of the curing agent causing the displacement of water from the surface of the substract, allowing the film to adhere and cure to a dense impermeable barrier [5].

The results of testings presented in Table I reflect that the coating systems shows excellent scratch hardness and impact strength. It is also observed that the strength increases with decrease in the proportion of the curing agent. This may be attributed to the increased proportion of epoxy content which is also responsible for the improvement in the flexibility of the coated film.

The coated films are also tested for the water and solvent resistancy. In case of water resistance, coatings based on all the resin systems show no colour change or blistering. The coated panels were immersed for 48 hours in water and solvent but no cracking or loss in gloss were observed which indicates that all the system have excellent solvent and water resistancy. Two % alkali solution test for 48 hours shows that all the panels were remained unaffected. The observation reveal that on exposing the coated panels to 2% H_2SO_4, no substantial loss in gloss or change in appearance were observed indicating excellent adhesion as well as good resistance to acid, alkali and organic solvents.

EXPERIMENTAL

Materials

DGEBA was obtained from Synpol Chemicals Ltd., Ahmedabad, India having epoxy equivalent weight 190; viscosity 40–10 poise and density 1.16–1.1 gm/cm^3 at 25 °C. The other chemicals used, ethylene diamine, propylene diamine, triethyl amine, methanol and methyl cellosolve were of laboratory reagent grade.

Synthesis of Resins

4-amino ethyl benzoate was synthesized according to the method given in a literature [6] (m.p. 88 to 90 C). The bisester derivative and two polyamides were prepared by the methods described in our earlier communication [4].

Coating on Mild Steel Panels

Coating compositions were prepared by combining DGEBA and two PAs in three different ratios viz., 60:40, 70:30 and 80:20. The compositions were then thinned with methanol: methyl cellosolve mixture (1:3) to the viscosity required for application and were made free from coarse skin by passing through 150 μm sieve (IS:460–1960). All resin systems were then coated on the mild steel panel (confirming to deep drawing quality according to IS: 513–1960, size 150 × 1.25 mm) using flat brush conforming to IS: 384–1964. The coated mild steel panels were immediately placed in vertical position for drying, then examined after specific time intervals for the tack free test and thermally cured.

Measurements

The films were applied on mild steel panels (6″ × 4″) and (6″ × 2″) and mechanical properties were studied according to Indian Standard Specification [7]. The flexibility was measured using 1/4″ and 1/8″ conical mandrel. The scratch resistance and adhesion were determined using IS methods [7]. Resistances towards water, acid, alkali and acetone were determined using standard methods described in the literature [8].

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