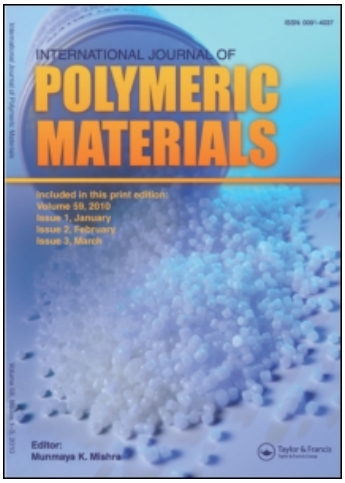

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Sanjay Patel[a]; Rajesh Baraiya[a]; Jitendra Patel[a]; Dipak Raval[a]; Jatin Thakkar[a]
[a] Department of Chemistry, Sardar Patel University, Vallabh Vidyanagar, Gujarat, India

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Epoxy Resins-Polyamide Coating System

SANJAY PATEL, RAJESH BARAIYA, JITENDRA PATEL, DIPAK RAVAL and JATIN THAKKAR*

Department of Chemistry, Sardar Patel University, Vallabh Vidyanagar-388 120, Gujarat (India)

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Bisester namely 1,1′-(1-methyl ethylidene) bis[4-{1-(1-imino-4-ethyl benzoate)-2-propanolyloxy}] benzene was synthesized by the reaction of epoxy resin (DGEBA) and 4-aminoethyl benzoate (4-AEB) using triethyl amine as catalyst. The synthesized bisester was reacted with three different aliphatic diamines viz; diethylene triamine (DETA), triethylene tetramine (TETA) and polyethylene amine (PEA) to obtained respective polyamide resins (PAs) abbreviated as DGEBA-4-AEB : DETA, DGEBA-4-AEB : TETA and DGEBA-4-AEB : PEA respectively.

The PAs synthesized were used as a curing agent for the difunctional epoxy resin (DGEBA) and trifunctional epoxy resin (TGPAP) in three different ratios. Using triethyl amine as a catalyst and PAs as a curing agent, DGEBA and TGPAP were polymerized on mild steel panels at 120°C for 1 hr. The coated panel thus obtained were tested for scratch hardness, flexibility, impact strength and chemical resistancy.

It appears from the results for the epoxy resins, epoxy based polyamides can successfully be used as a curing agent for the coating application.

Keywords: Epoxy resin; scratch hardness; impact strength; chemical resistancy; flexibility

INTRODUCTION

Epoxy resin have attained a prominent position in industry. In their fully cured state, they have remarkable properties to solvents, acids, base and heat [1]. In addition, the low cost of these resins have prompted its use as substitutes for phenolics in various important applications [2, 3].

*Corresponding author.

Epoxy resins are no longer a novelty to the coating industries also. 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 at all 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, industry, millitary and aerospace usage etc. [4].

The reaction of epoxy ring with amine and alcohol is well established [5] and hence the reaction of epoxy resin with an organic compound having amino and ester group like 4-amino ethyl benzoate may yield bisester derivative, which may afford polyamide on further condensation with diamine.

Hitherto, most of the commercial polyamides are prepared from dibasic acids and diamines. Polyamide formation through epoxy resin based bisester has not received attention inspite of well defined applications of both epoxy resin and polyamides.

Polyamide resin adducts have recently appeared on the market. These curing agents provide epoxy coatings with improved gloss and flow, better water and chemical resistance, and offer greater freedom from surface exudation problems if the coating is applied under adverse weather conditions [6].

It has been reported that the polyamide curing agent displaces the water from the surface of the wet substrate, allowing the coating to adhere and cure to a dense, impermeable barrier [4].

The great deal of work of epoxy resin based polyamide has been carried out in our laboratory [7]. The work was mainly based on curing study of epoxy resins using epoxy resin based polyamides as curing agent. The present communication is in connection with the polymerisation of difunctional and trifunctional epoxy resin (i.e., DGEBA and TGPAP) on the mild steel panels and to carry out the comparative study of coating properties.

EXPERIMENTAL

Materials

DGEBA was procured from Synpol Chemicals Ltd.; Ahmedabad, India having epoxy equivalent weight 190–210, viscosity 4–10 poise

and density 1.16–1.17 gm/cm^3 at 25°C. Triglycidyl *p*-amino phenol (TGPAP) synthesis in the laboratory. 4-amino ethyl benzoate was synthesized according to the method given in a literature (m.p. 88 to 90°C) [8]. The bisester derivative and three polyamides were prepared by the methods described in our earlier communication [7].

Coating on Mild Steel Panels

Coating compositions were prepared by combination of epoxy resin (DGEBA and TGPAP) and three PAs in three different ratio viz., 60:40, 70:30, and 80:20. The compositions were then thinned with methanol:methyl cellosolve mixture (1:3) to the required viscosity 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 as per IS: 513 – 1960; size 150×1.25 mm) using flat brush confirming to IS: 384 – 1964. The coated mild steel panels were placed in vertical position for drying immediately; then examined after specific time intervals for the take free test and cured thermally.

Measurements

The films were applied on mild steel panels (6″×4″) and mechanical properties were studied as per Indian standard specification [9]. The flexibility was measured using 1/4″ and 1/8″ conical mandrel. The scratch resistance and adhesion were determined as per IS methods [9]. Resistance towards water, acid, alkali and organic solvents were determined as per standard method described in the literature [10].

RESULTS AND DISCUSSION

The polyamides (PAs) was prepared by the reaction of the bisester derivative (i.e., DGEBA-4-AEB) with various aliphatic diamines. All the polyamides were obtained with high yield. Bisester was synthesized by the reaction of epoxy resin (DGEBA) and 4-amino ethyl benzoate (4-AEB) using triethyl amine as a catalyst.

The curing temperatures were decided from the evaluation of dynamic scans obtained from differential scanning calorimetry (DSC) [7].

Data furnished in Table I are regarding the scratch hardness, impact strength and flexibility test of the coated panel using various system in different ratio has been prepared for the study.

All samples passed flexibility test of 1/4″ and 1/8″ conical mandrel, which confirm the good flexibility of the coated film. All the panels passed stripping test for adhesion, which is expected of free hydroxyl group present in the resin system which contributed in the strong metallic bond formation with the surface of the mild steel panels. The good adhesion of the film may also be due to the possibility that polyamide characteristics of the curing agents displaces the water from the surface of the substract, allowing the film to adhere and cure to a dense impermeable barrier [4].

Data listed in Table I indicates that TGPAP resin systems show better coating properties than the system where DGEBA was used. This difference may be responsible for the higher functionality of the TGPAP resin. The higher functionality of this resin leads to higher

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

System Resin:Curing agent	*Ratio (in wgt%)*	*Flexibility*	*Impact Strength*	*Scratch hardness (gm)*
DGEBA : A	60:40	Pass	160	1200
DGEBA : A	70:30	Pass	175	1250
DGEBA : A	80:20	Pass	190	1325
DGEBA : B	60:40	Pass	180	1275
DGEBA : B	70:30	Pass	190	1375
DGEBA : B	80:20	Pass	205	1425
DGEBA : C	60:40	Pass	205	1340
DGEBA : C	70:30	Pass	215	1400
DGEBA : C	80:20	Pass	230	1450
TGPAP : A	60:40	Pass	210	1290
TGPAP : A	70:30	Pass	225	1350
TGPAP : A	80:20	Pass	250	1425
TGPAP : B	60:40	Pass	230	1360
TGPAP : B	70:30	Pass	240	1325
TGPAP : B	80:20	Pass	255	1400
TGPAP : C	60:40	Pass	255	1385
TGPAP : C	70:30	Pass	270	1425
TGPAP : C	80:20	Pass	285	1500

DGEBA : Diglycidyl ether of bisphenol-A
TGPAP : Triglycidyl ether of para amino phenol
A : DGEBA-4-AEB : DETA Polyamide.
B : DGEBA-4-AEB : TETA Polyamide.
C : DGEBA-4-AEB : PEA Polyamide
4-AEB : 4-amino ethyl benzoate.

crosslinking in the cured material. It is also observed that both the strength increase with decrease in the proportion of curing agent. This may be ascribed to the increased proportion of epoxy content which is also responsible for the improvement in the flexibility of the coated film. Aliphatic amines have a long aliphatic chain which is responsible for the flexibility of the coated film.

The coated films are tested for the water and solvent resistancy. In case of water resistancy, coating 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 Two % H_2SO_4 for 48 hours no substantial loss in gloss or change in appearance were observed indicating excellent adhesion as well as good resistance to acid, alkali, water and organic solvents.

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