Mechanical properties of Epoxy – polyurethane polymer blends

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Abstract:

Binary blends have been formed for epoxy (EP) and polyurethane (PU), the concentration was chosen to give 4 compatible thermoset-thermoset blends (80-20, 60-40, 40-60, 20-80) EP-PU. Samples were cast as sheet of 4mm thickness prepared from simultaneous mixing of the two constituents in the required percentage. Standard impact samples (ISO 179) were prepared and mechanically tested by Charpy test either as prepared or after being heat treated, aged at 75c° for 3, 6, and 9 hrs. The results showed that the increment and / or decrement of impact toughness depend on blend concentration, and thermal aging to some polymer blends.

In addition to the impact tests, the morphology by scanning electron microcopy was carried out to investigate whether these blends are classified as compatible blends.

The aim of this research is to product a new polymer material with new properties. Especially the mechanical and physical properties.

Introduction

Plenty of people are actively involved new a day with polymers as new materials with new properties and new application [1].

The importance of polymers is still regarded as cheap alternative materials that are easily replaceable and disposable [2].

The intensive use of polymer for broad use has lead to the development of materials for specific application based on specific properties [3].

Polymer blends are defined as any combination of two or more polymers resulting from common processing step [4], [5].

Polymer blend may also be defined as intimate mixtures of two kinds of polymers, with no covalent bonds between them [6], or that are not bonded to each other [7]. Blending of polymer, therefore, are excellent methods for modification and improvement of polymer properties [8], [9]. Blend display widely varied behavior from brittle to strong and flexible [10].

The dendrite structure lead to crystallinc polymer Co- continuous morphologies have extensively analyzed for their improved mechanical properties [11],[12].

Previous research in our laboratory and elsewhere has shown that synergism can exist in certain polymer pairs which lead to enhanced some of physical and mechanical properties [13].

Significant improvements in impact resistance and toughness are usually noted for such blends [6].

Impact test

Impact resistance is a measure of the ability of a material or structure to with stand certain level of the application of a sudden load without failure.

The impact resistance of a structure is therefore a complex function of

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geometry, mode of loading, load application rate, environments, material type, material properties, and quite importantly, the definition of failure [14].

Test of impact is Charpy method; the specimen is notched (some time unnotched) [15, 16], and supported horizontally against the stops at either end.

In this method, a free- swinging pendulum with a round –up mount is used as an impactor. A single value of total absorbed energy is obtained by measuring the energy left in the pendulum after completion of the impact fracture [17].

The Charpy impact strength of un-notched specimens (G), in kilojoules per square meter, is given by [15]:

$$G = \frac{U}{X * Y} * 10^3 \qquad \text{----------(1)}$$

Where U is the impact energy, in Joules, absorbed by the test specimen, X is the width in (mm) of the specimen, and Y is the thickness in (mm) of the test specimen.

Effect of curing on mechanical properties

Thermal degrative stability has been related to degree of cure [18]. Overall activation energies for thermal decomposition were determined as a function of curing temperature from both isothermal and dynamic thermogravimetry.

These results are consistent with the view that higher cure temperature result in higher degree of cross-linking causing an increase in the energy to degrade the products.

Experimental work

The properties of Epoxy-polyurethane (EP-PU) blends and sample cutting are given elsewhere [19]. For impact measurements sample of dimension (60mm * 6mm) and with thickness 4mm (with notch (un notched)) according to ISO-179, 1982(E).

The result of impact measuring with verimes thermal aging (3,6,9 hrs) of EP/PU blend as shown in fig (1)& (2).

The morphology of the blend surface was examined by JEOL SEM model JSM- 6400 at 19 kV accelerating voltage.

Before tested all samples were gold-coated with fine coating of approximately 300 A° using JEOL model GFC- 1100E on sputter.

Determine of miscible and immiscible (or the compatibility of EP-PU) blends morphology was achieved by scanning electron microscopy Fig [3] illustrated the morphology of the 80% EP /20% PU blend.

Discussion and conclusion:

For the various concentration of EP/PU blend, the impact value of EP was found to be higher then that of PU Figures (1, 2). As blend the best impact values were found to be at 20/80 and 80/20 concentration ratios. Impact values of samples formed with concentration ratios in between were generally less. The highest impact performance was related to the best compatibilities observed at these tow ratio, the SEM investigation Figure (3) support this expectation where no distinct phase separation was observed full IPN. Such results are in good agreement with what had been observed by other researcher, where the best IPN was detected at 70/30-concentration ratio [20, 21].

Cross- linking process raised the impact ratio for the tested sample Figure (2) however only 3hrs of aging time was found to be enough to produce thermal degradation the blend samples and consequently the impact performance was reduced in pure epoxy to where at lest 6hrs aging time was required to produced such effect.

The morphology of thermally aged epoxy samples allowed some

structured performance caused either by raising temperature and/or aging time Fig (4).

Higher temperature aging time may deteriorate the mechanical properties of any blend system that used epoxy as a damping material [21].

In conclusion, this work recognizes that:

1. EP&PU are two polymers which compatible and good blends for
2. The impact value of EP was found to be higher then of PU.
3. The best impact values were found at 20/80 and 80/20 concentration ratios.
4. Thermal aging time about 3 hrs only was found to be enough to produce the best impact properties value.

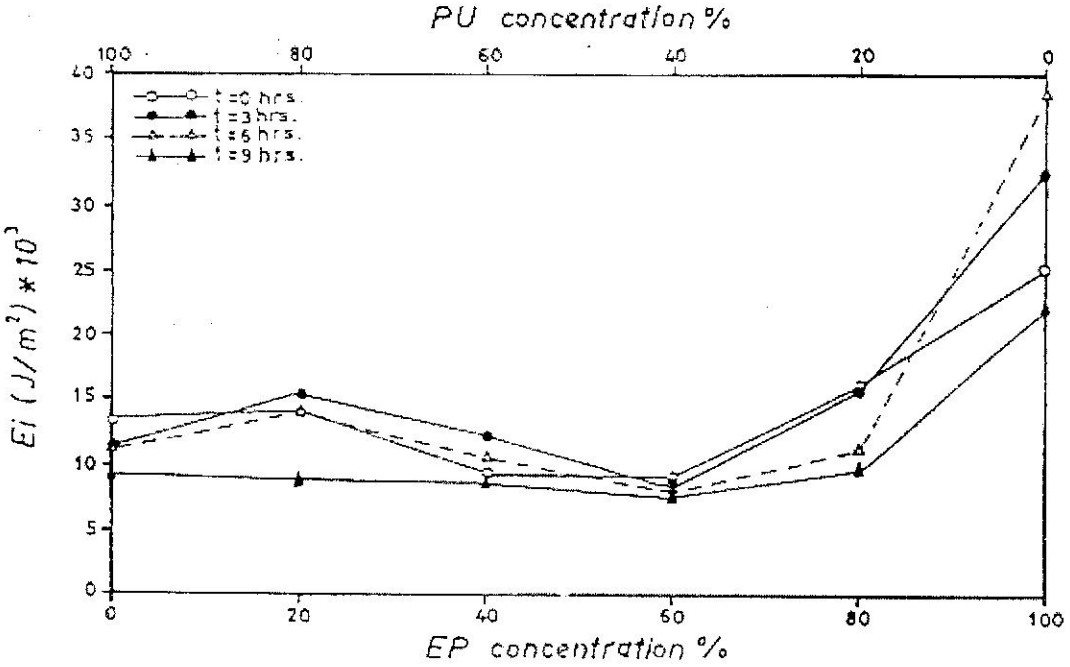

Fig (1) Impact energy per unit area vs. EP/PU concentration at 75 °C for different thermal aging time.

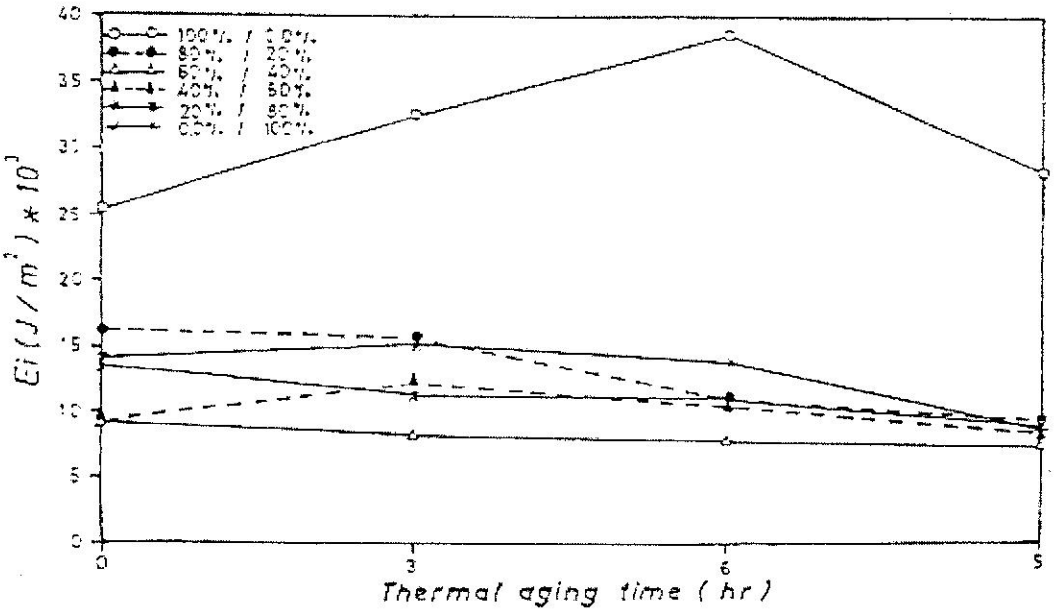

Fig. (2) Impact energy per unit area vs. thermal aging time of EP/PU group blend of different composition at 75°C.

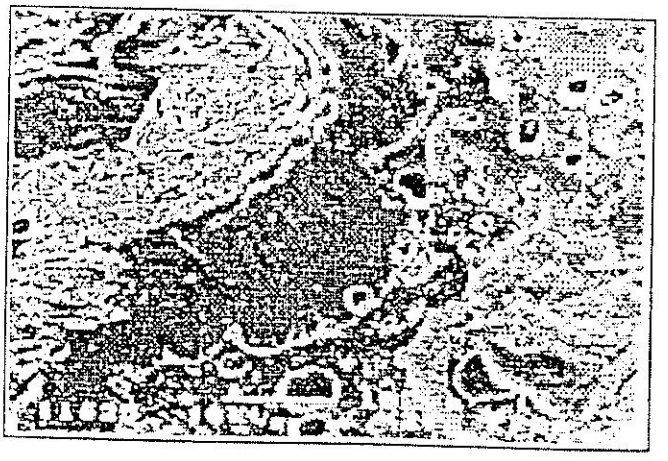

Fig. (3): SEM Micrograph of 80% EP/ 20% PU blend

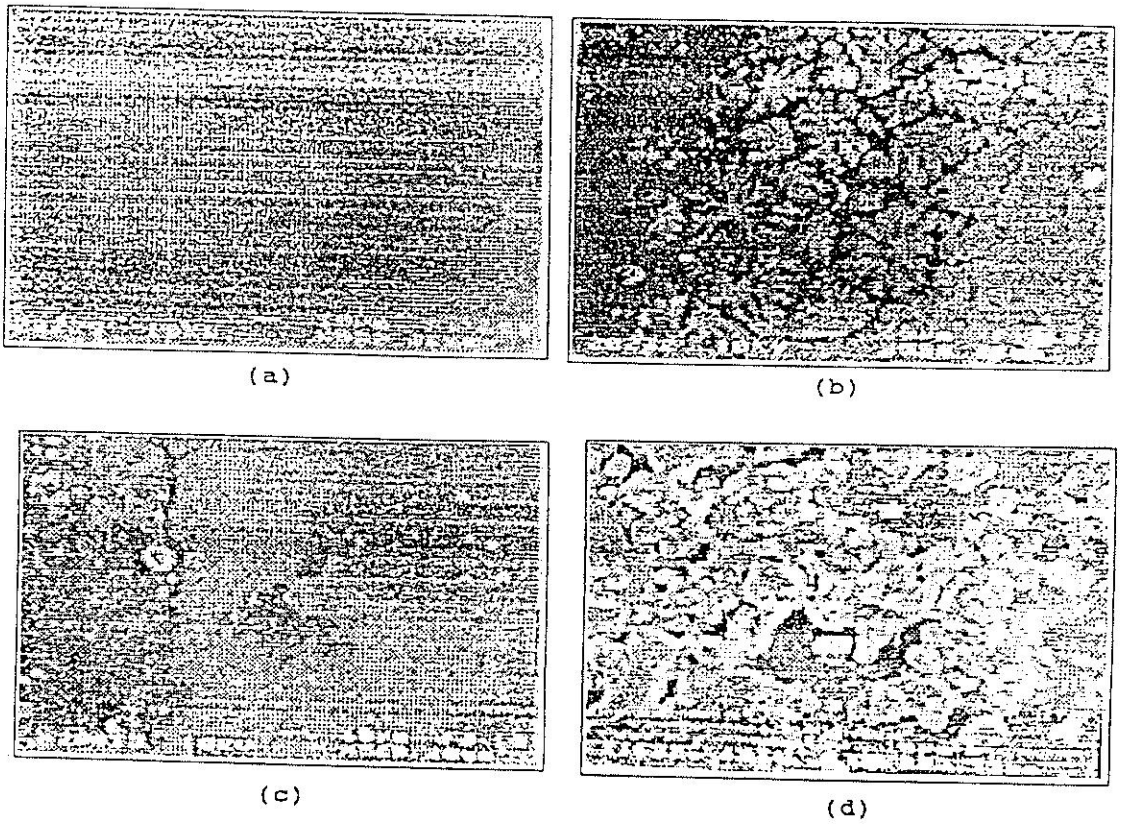

Fig. (4): SEM micrographs of 100% EP
(a) general.
(b) dendrite structure.
(c) post cured at 75 °C for 3 hrs.
(d) thermal aging effect for 6 hrs at 75 °C.

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الخصائص الميكانيكية للخلطة البوليمرية ابوكسي – بولي يوريثان

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الخلاصـــة:

تم تكوين خلطات بوليميرية ثنائية من الابوكسي والبولي يوريثان. وتم اختيار نسب متباينة من هـذه المواد أدت إلى إنتاج (4) خلطات متجانسة من الثرموست –الثرموست وبالنسب (,80-20 60-40, 40-60, 20-80) ابوكسي – بولي يوريثان.

تم صب النماذج المطلوبة على هيئة ألواح بسمك (4) ملم بعد الخلط المتـزامن فـي وقـت واحـد للبوليميرين المكونين للخلطة البوليميرية وبالنسب المطلوبة.

اجري اختبار مقاومة الصدمة وكذلك اختبار فحوصات المجهر الإلكتروني لمعرفة فيما إذا كانت هذه الخلطات منسجمة أو غير منسجمة. تم اختيار المواصفة (ISO 179) لفحوصات مقاومة الصدمة وبطريقـة (Charpy) للعينات سواءً كانت قد أجريت عليها معاملة حرارية بدرجة°75 ولمدة (9,6,3) ساعات أو بدون معاملة حرارية وأوضحت النتائج بان زيادة قوة مقاومة الصدمة أو نقصانها يعتمـد علـى تركيـز الخلطـة البوليميرية والمعاملة الحرارية لبعض الخلطات وبدرجة متفاوتة . يهدف هذا البحث لأنتاج مـواد بوليمريـه جديده بمواصفات جديده وخصوصا المواصفات الفيزياويه والميكانيكيه.