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An Environmental Friendly Material:Epoxide-Based Resin from Vegetables Oil for Bio-Fiber Reinforced Composites

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Abstract
The growing interest in reducing environmental impact of polymers or composites due to increased awareness to eco-friendliness. The finite petroleum resources has impacted to decreased pressures for the dependence onpetroleum products which has increased in maximizing the use of renewables material. Bamboo are used for principal constituent of reinforced composite which incorporated to epoxide based resin from vegetables oil; canola, soybean, corn, and sunflower. The products obtained resulted the promising composites material for green environmental and also acceptable mechanical property.

Keywords: Environmental, bio-epoxide resin, vegetable oils, composite material

Introduction

The shortage supply of non-renewable resources has urged to using renewables material. The use of large volumes of polymer based synthetic fiber composites in many sector despite their high cost has led to disposal problems. The synthetic material are well established for a wide variety of applications. (AK Mohanty, M Misra, G Hinrichsen, 2000; 276:1-24); (D Cho *et. al*., 2002); (AK Mohanty, M Misra, LT Drzal, 2002); (T Peijis, 2003); (P Wambua and Ivens J, 2003). Many research has explored of using technological innovations as an effort to save environmentt (Kong and Narine, 1997); (Petrovich, Zhang, Javni, 2005), by switching the raw materials into vegetable oils; low toxicity, soluble, and high purity (Guner, Yagci, and Erciyes, 2006).

A greater environmental conciousness have established the use of bio- fiber which triggering greater effort to find materials based on natural resources in latter's eco-friendly attributes.The significant attraction of bio-fibers is their low cost and some unique attributes, such as being less abrassive to tooling yet effective surface treatments avoid organic solvent are logical to make the reactive surface. Alkali treatment is an effective method to improve fiber-matrix adhesion in bio-fiber composites. The hybridization to non degradable polymeric matrices which may make it not fully biodegradable. Hybridization effect of bio- fibers with synthetic fibers on various properties has been extensively studied, very limited studies with hybrids of bio-fibers mainly with non degradable matrices have been reported (KG Satyanaryana, F Tomczak, THD Sydenstricker, 2006). In order to produce fully renewable and biodegradable composites both the polymeric matrix and the reinforcement must be derived from renewable resource, normally produced by plants in a period of less than one year (Narayan, 2006). Bamboo stick will degrade in 1-3 years while plastic 450 years and glasses and tyres uncertain time, including most biodegradable materials including composites, degrade rapidly in 2 weeks to 6 months (KG Satyanarayana, *et al*., 2009). The major objection of using natural fiber for reinforcement in thermosettingmatrix resin is to achieve improved mechanical property of composite material due to poor wettability and weak interfacial bonding; a hydrophilic fiber to hyrophobic matrix (Carvalho, 1997); (Marcovich *et.al*., 1997). Bamboo fiber has superior mechanical properties but the brittleness can not be avoided because fiber covered by lignin.

This research has been carried out to find the optimize mechanical properties of 4 kind epoxide vegetable oil (canola, soybean, corn, and sunflower) based resin with in binding the surface of bamboo which giving the best mechanical properties.

Experimental Procedures

Materials

In this research, 4 kinds of natural oils used; canola oil, sunflower oil, and corn oil the products are produced by Switzerland AG Coda- Mazola and soybean oil by Salim Ivomas Jakarta. TheC-C double bond in tryglyceride were transformed into epoxide by peracetic acid *in situ*.The products so called as epoxy resin; blended of epoxy from natural oil with hardener which manufacture by polychemie Indonesia in the ratio 1:1, the resin isperformed as matrix of fiber reinforced composite. The resin are then applied to bamboo fiber (*Gigantochlea Apus*) was obtained from its stem now mainly cultivated in Bogor West Java- Indonesia. The specimen were cut into the dimension of (lenght x width x thickness) in general (10.05 x 2.05 x 0.2) cm^3.

Property of vegetable Oil

The density of the resins; blending of epoxide natural oil with hardener; canola resin was 0.4949 gr/cm^3; sunflower resin was 0.4949 gr/cm^3, and soybean resin was 1.4401 gr/cm^3while synthetic epoxide resin was 0.7175 gr/cm^3. The property of natural oil's and its epoxide forms are depicted in table 1.

The chemical structure, with many hydroxyl groups interact with water molecules. The cellulosic fibers interact with water not only at the surface, but also in the bulk. Due to storage without any treatment the bamboo fiber kept water on a specified moisture which can lead to mold formation on the surface and effected to weaken mechanical properties.

Table 1: Property of vegetables Oil and its epoxide forms

No	Natural Oil	Iodine Value (% wt)	Oil in epoxide Form	
			Acid value (mgr KOH/gr)	Oxirane (mgr KOH/gr)
1	Canola	92.89	2.558	3.4
2	Sunflower	82.7	2.2	6.5
3	Soybean	86.7	0.0244	6.68
4	Corn oil	89.9	1.5	3.0

Figure 1: Bamboo fiber without Alkaly Treatment

In this research, the treatment was done by alkalyusing NaOH solution with variation of the concentration of 0 %, 5 %, 10 %, 15 % (v / v).

Methods

a. Tensile Strenght Test: The test was designated as ASTM D3379. Using Shimadzu AGS-50kN Xplus, with room humidity 50.5%. The tensile test was carried out within speed of testing 2 mm/min with grip distance 50 mm. The dimension of bamboo fiber specimen was 10x 2 x 0.2 cm^3
b. Bending strenght: The test was designated as ASTM D3379 using Shimadzu AGS-50kN Xplus with room humidity of 53%. The pressure rate 1.651 mm/min. The grip distance is 25 mm.
c. Compressive strenght: The test was designated as ASTM D3039 using Shimadzu AGS-50kN Xplus. With humidity of 53%. The pressure rate 1.3 mm/min. The grip distance is 25 mm.
d. The cellular images after compressive strenght application to bamboo reinfoced composite were characterized using SEM micrograph using Philip SEM-DAX XL30 W/TMPPW6635/15 using ASTM D 3036

Results and Discussion

Tensile Strenght of Composite fibers

The typical tensile strenght of bamboo using 4 kinds epoxide resin are remarkably low with the higher concentration of alkali. Infact alkaline solution immersion leading to the formation of larger number of voids. Lost of cuticle leads to rough surface (Sreekala *et.al*., 1997).

The concentration 5% of NaOH is in the range of 3.06-7.58 [MPa] (Figure 2), compared to using E-glass 2.5 [MPa];

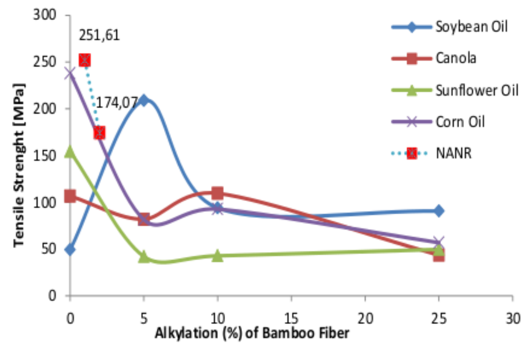

Figure 2: Alkylation concentration of bamboo fiber to Tensile strenght of composite [a]NANR: no alkylation no resin

Kevlar 2.5-3.7 [MPa], and Carbon 1.4-1.8 [MPa] (Amar, Manjusri, Lawrence, 2005), it seemed this is the optimum condition to removed lignin and result the good tensile strenght.According to Joseph *et.al*., the mechanical properties of alkali treated sisal fiber is tensile strenght 34.27 (MPa), elongation at break 1 (%) while for untreated sisal fiber is 31.12 (MPa), modulus 3086 (GPa), and elongation at break 2 (%).

Elongation of Composite fibers

The elongation test found in this research, is high until 5% using soybean epoxide resin, but 10% is high for canola, sunflower oil, and corn oil epoxide based resin. The elongation existence is poor with alkylation more than 15% (Figure 3).

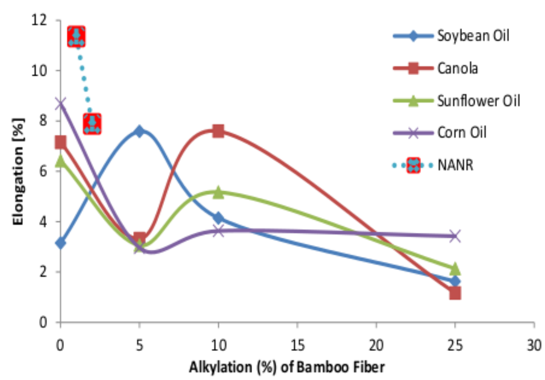

Figure 3: Alkilation concentration of bamboo to Elongation of composite fiber [a]NANR: no alkylation no resin

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Compressive Strenght of Composite fibers

The compressive modulus in general is high with alkali treatment 10% for all epoxide vegetable (canola, soybean, sunflower, and corn) oil based resin. The compressvie strenght of bamboo fiber are poor with alkali treatment. In general the compressive is in optimum condition with the treatment of alkylation in the concentration 5% (Figure 4).

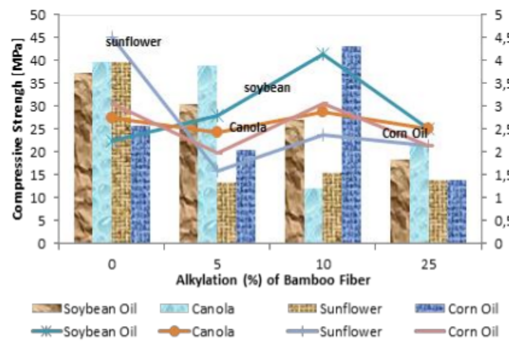

Figure 4: Alkylation to Compressive Strenght of composite

Bending Strenght of Composite fibers

The bending strenght and bending modulus of fiber composite reinfoced it seems to be improved using thermosetting epoxy. The alkali treatment until concentration 25% is seemed not to be effected the bending (Figure 5).

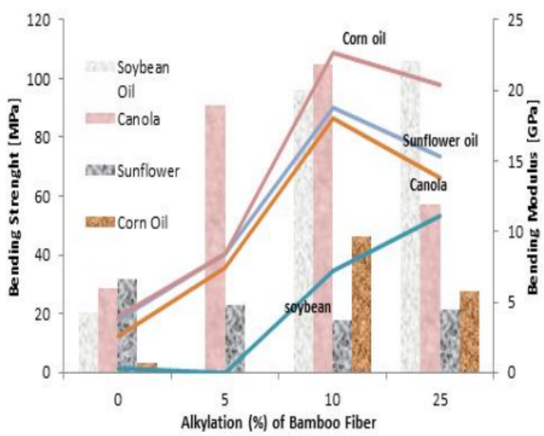

Figure 5: Alkylation to Bending Strenght and Bending Modulus of Composite fiber

Morphology of composite fibers

Good bonding between matrix and epoxy of vegetables (canola, soybean, sunflower oil, and corn oil) based resin of microfiber phase were observed in all samples. This fortunate fact because the alkali treatment has made the matrix fiber dissolved in the surface through the bulk.

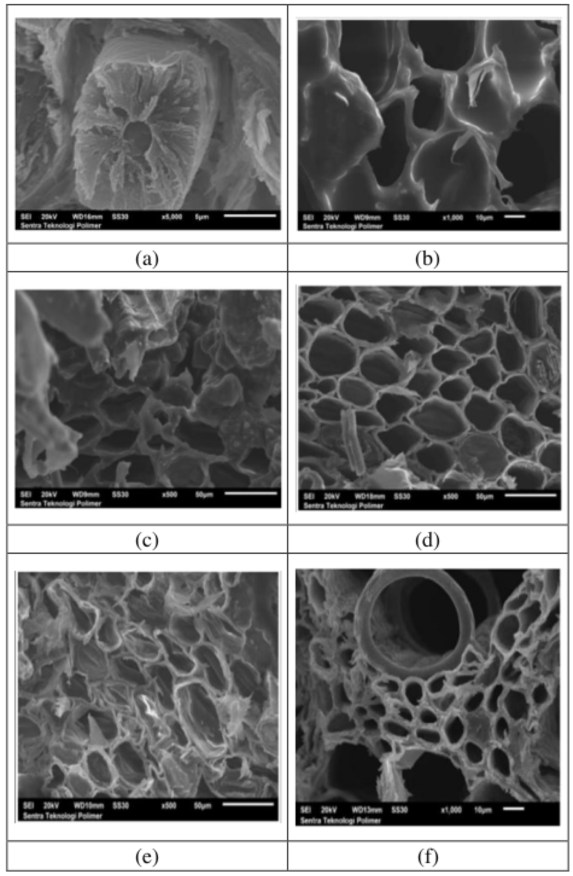

Figure 6: SEM micograph after compressive of composite a) Canola resin without alkaly treatment previouslyb) Canola with 5% alkaly c) Canola with 10% alkaly d) Canola with 25% alkaly e) fiber without alkaly treatmentand withoutresin f) Soybean with 25% alkaly treatment

Conclusion

Four products of composite with bamboo fiber reinfoced were synthesized by using epoxide form of 4 kind of vegetables oil (canola, soybean, sunflower oil, and corn oil) based resin. The oil, the epoxide were characterized by chemical and physcial method. The composites were characterized by mechanical properties. As in general the properties are quite promising to petroleum based.

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