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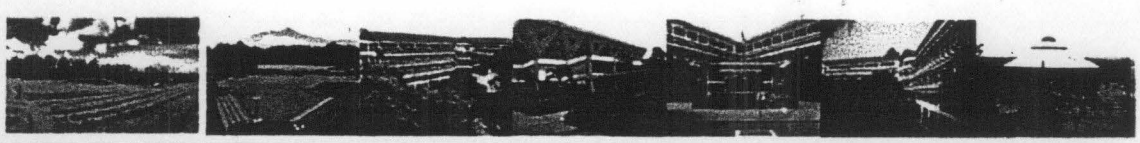
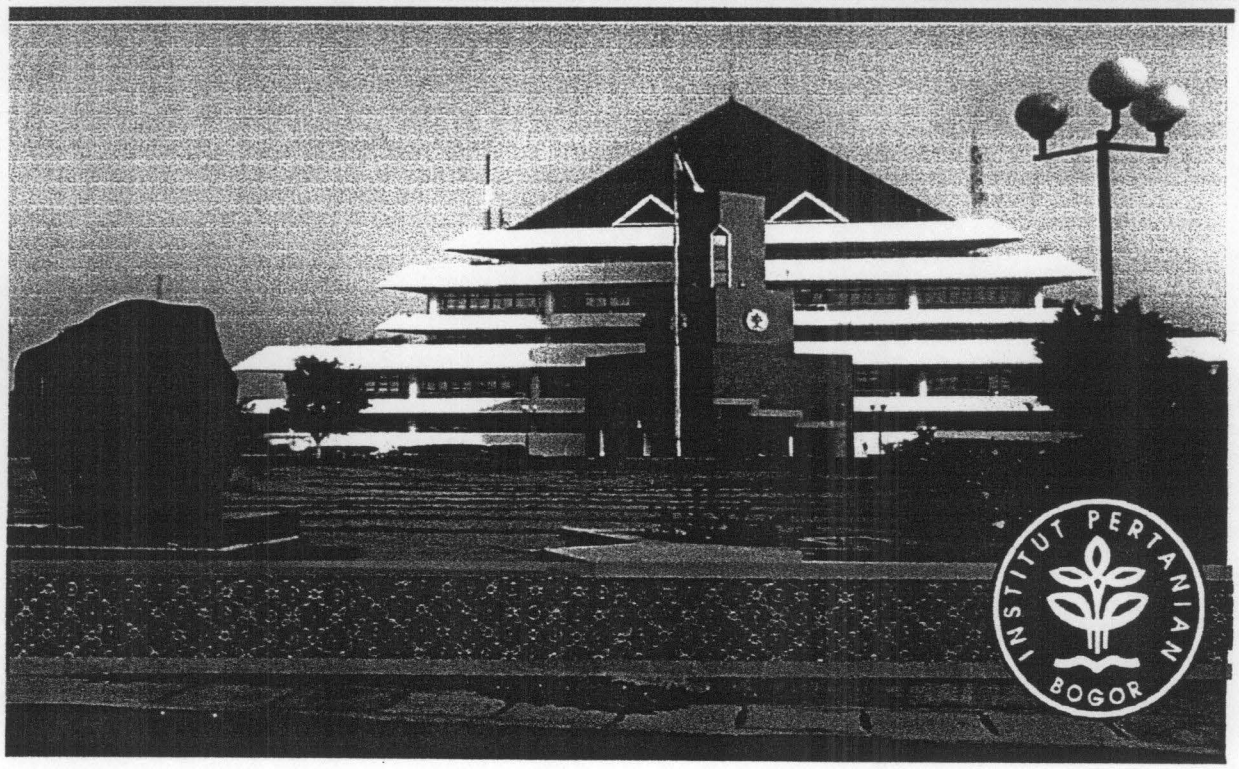
Proceeding

Role of Asia in Communities and Sustainable Development





Proceeding

The 19th Tri-University

International Joint Seminar and Symposium 2012

Role of Asia
in Community & Sustainable Development

Directorate of Collaboration and International Programs

Bogor Agricultural University (IPB)

Bogor, 22-25 October 2012

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PREFACE

Praise be to God Almighty for enabling us to publish the proceeding of 19th Tri-University – International Joint Seminar and Symposium which has been conducted on 22-25 October 2012 at Kampus IPB Darmaga, Bogor.

The theme of the conference was focused on the Role of Asia in the Community & Sustainable Development. Papers presented in the conference were divided into five categories, Tetralema (Food, Population, Energy & Environment) plus Ecology. There were 98 papers presented orally by students and lecturers

We would like to express our gratitude to all speakers who have contributed their papers try to be published in this proceeding. Thank you to IPB and all parties who have sponsored this event. To all members of steering and organizing committee who have contributed to the success of the event we would like to express our sincere appreciation.

We also would like to apologize to all of participants if in conducting this event there are some shortcomings that cause the participants feel not comfortable. We hope that this proceeding contribute to the establishment of science and technology in food, population, energy, environment & ecology in Asia.

Bogor, October 2012
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Desrial

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THEME D-ENVIRONMENT

D-05

Alternative Utilization of Rattan Bark Fiber as Bio-Nano Reinforced Plastic (Composite) and Possible Applications for Automotive Components

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Abstract

Rattan bark fiber is waste of raw rattan production activities. It usually used for roofing houses and strap goods in the traditional markets. Rattan bark fiber containing about 40% cellulose, which was potential to be used as filler for automotive components (or recycling). Nanotechnology based on nano particles with High Energy Milling (HEM) has been applied in this research to find the optimum particle size to be implemented as automotive component filler. Three HEM has been applied (1 hour, 5 hours, and 10 hours), and without HEM (0 hours) as control. Measurable particle size is the size of the single particle. Data in the form of three particle size distributions, intensity, number and volume of distribution, so it can be assumed to describe the overall condition of the sample. The result shows that 5 hours milling produce the smallest particle size (16.22 nm) and z averages (129.78 nm). Particle Size Analyzer (PSA) results was related to the Scanning Electron Microscopy (SEM) images of 5 hour milling, particle become smaller and look the same or homogeneous as balls. These result indicate that the cellulose in the form of three-dimensional nano particles are spherical, and the mechanical tests shows that bio-composite rattan bark fiber performance was highest among the other natural composites (kenaf, acacia, water hyacinth, banana, and coconut).

Key words: bio-composite,high energy milling, nano particle, rattan bark fiberautomotive components

1 Introduction

The usage of synthetic fibers in the composite was increased. But it create problems due to the waste from synthetic fibers could not be degraded naturally. In response to these problems, Europe and some Asian countries set up a regulatory requirement consumables (end of life). In this regard, the use of natural fibers is one of the best choices [1]. Rattan bark fiber waste has the potential to be utilized as raw material as bio-composite since it was a natural fibrous material containing an average of 45% cellulose and available throughout the year from rattan forest [2]..

Nanotechnology is important in engineering material, because people always trying to integrate a function or a job in a smaller scale. Integrating a function machines or products in smaller size means not only beautify but also minimize the energy requirement, speed up the process and reduce production cost. One of its applications is the synthesis of rattan bark waste in the form of nanoparticles on bio-nanocomposite applications using High Energy Milling (HEM).

To produce bio-nanocomposite with optimum physical and mechanical properties, required input data (frame of reference) relating to the microstructure and mechanical properties of the constituent elements that could answer the needs for composites.

2 Materials and Methods

2.1 Materials

The material which has been used in this study were rattan (c.scipionum Burr), polipropillen, PPMA, and ethanol.
The tools which has been used are disk mill, electromagnetic shaker, high energy milling E-3D, electron microscopy scanner, particle size analyzer, single screw extruder, compression molding, and ASTM D638 tensile test tools.

2.2 Methods

The research starting with the stage of the synthesis and characterization of rattan bark nano particles, sample preparation and synthesis of nano particles with HEM. Selected rattan bark was boiled and dried to ensure rattan really dry and soft, then milling and shaking (using a disk mill and electromagnetic shaker) to get the size of <75 μm. Furthermore, the sample with size of <75 μm was milling (using HEM) in 3 treatments: 1 hour, 5 hours and 10 hours.

Characterization of nanoparticles using Particle Size Analyzer (PSA) was done to determine the size of the nanoparticles, and Scanning Electron Microscopy (SEM) was use for surface morphology analysis.

At the stage of the synthesis and characterization bio-nanocomposite, polipropillen polymers has been used as matrices and rattan bark fibers as filler. Composition of bio-nanocomposite polipropillen was 93%wt, rattan bark fiber 5%wt and PPMA 2%wt. Samples were prepared by using extrusion equipment for materials mixing, then compressed in the molding and punching to get the size of the specimen in accordance with standard mechanical characterization (tensile test)

3 Result and Discussion

Cellulose $(C_6H_{10}O_5)x$ is a major part of woody plants that make up the component pieces lengthwise. The separation of the good fiber and guarantee the optimal condition and original content of fiber can be maintained. The basic principle of the fiber separation is separated from the building blocks of non-cellulose fibers and allowing the fibers to be mechanically extracted after drying [3].

Figure 1 shows that the extraction of cellulose bark of rattan, which was produced by a disc mill, produce fibers on the size of the stages are : long fiber, 5 cm, 1 mm, and 500 μm to <75 μm. Fiber size order of <75 μm was followed by using HEM tool to obtain the order of nanometer size particles. The purpose of the preparation of cellulose rattan bark is to simplify the optimization process of cavitation HEM.

Figure 2 shows that during the HEM, collisions between balls with rattan bark fibers with speed 1400 rpm vial can destroy the fibers and soften up the nanometer size, cavitation process marked after milling rattan fiber bark smoother and shrink.

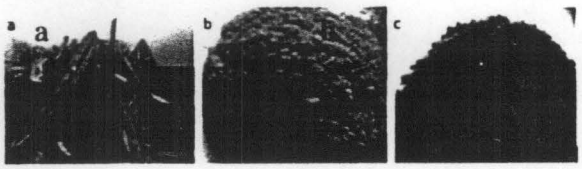

Figure 1 Rattan bark fiber produced by disc mills : long fiber (a), particles <75 μm (b) nanoparticles (c).

Figure 2 High Energy Milling Process rattan bark fibers fiber filled vial and balls (a), after the milling process (fibers shrink), (b) fiber milling yield (c).

HEM using three-dimensional motion and rotation in the vial so that the mechanism of nanoparticle formation process amorfisasi and more quickly and effectively. HEM can be used for mixing, homogenizing, mechanical milling, mechanical alloying, and make the emulsion. The advantage is manufacturing nanoparticles without the addition of chemicals, smoothing material to the nanometer scale, to mixing (mixing) and uniformity (homogenization), making alloys making mechanical-chemical reactions [4].

To determine the particle size rattan bark fibers used HEM results of the two approaches, namely using the PSA analysis and SEM. Characterization of PSA, where the particles dispersed in a liquid medium so that the particles are not mutually agglomeration. Measurable particle size is the size of a single particle. Data obtained in the form of three particle size distributions, namely intensity, number and volume of distribution, which can be assumed to describe the overall condition of the sample.

Table 1 indicates the results of HEM from 1-10 hours. 1 hour of milling has a minimum particle size of 81.30 nm and then at 5 hours is optimum HEM and produce a homogeneous particle cavitation until 16:22 nm but the size of the rise time is 10 hours milling 22:39 nm. This is due to the filler is an organic material, so it has the nature of a special sensitivity to temperature compared with the inorganic material / synthetic.

Table 1 Comparison of PSA results

Time (h)	Minimum (nm)	*Modus* (nm)
1	81.30	269.22-309.11
5	16.22	16.22
10	22.39	22.39

Besides, the longer the time HEM, heat during the process also increased and the constituent atoms of the sample has a margin of arrangement or amalgamation themselves up after a vibration, lattice vacancies and disorder caused by the temperature.

SEM data processing based on the detection of secondary electrons (reflection) of surface samples. Electrons do not penetrate the footage but only reflected the result of the collision of electrons with the surface of the footage captured by the detector and processed into an image that has been magnified object structure.

Figure 3a shows the SEM image before the HEM, which form elongated fibers with a diameter of <50 μm. In this SEM image looks a black spot organic components (trakeid), where the pores are connected to one another with a substance lignin. This is what distinguishes between natural fibers with synthetic fibers. Synthetic fibers are made from inorganic materials with specific chemical composition that can be set according to the application needs, so that the nature and relatively uniform size and strength of the fiber can be pursued together along the fiber.

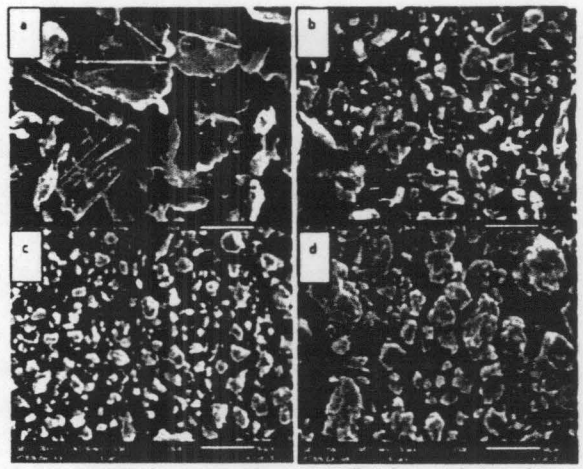

Figure 3 SEM image at 500x magnification variation time 0 hour (a), 1 Hour HEM (b), 5 Hours HEM (c) and 10 Hours HEM (d).

SEM image of Figure 3b shows that 1 hour HEM process produce fiber size smaller than without HEM process. While Figure 3c SEM image showing that 5 hours HEM process makes particles become smaller and look alike or homogeneous as balls. While the SEM image of Figure 3d shows that result of 10 hour HEM process nearly equal to 5 hours of milling, but different sizes because some particles are agglomeraton and making it looks bigger. The growth rate depends on the temperature. Increased temperatures increase the thermal vibrational energy, which includes atoms accelerate grain boundary diffusion of small grain into large grains [5].

Extrusion is the treatment process, combination of mixing, kneading, agitation (shearing), heating, cooling, and printing (shaping). The principle of operation is the same for all extruder. The raw material is inserted and passed along the extruder. When moving along the extruder, die small volume limit and hinder the movement of materials. As a result of high pressure materials. During moving along the extruder, screw rotate materials (kneading) and turn it into a semisolid which is plastic. Mixed polipropillen, PPMA and rattan bark fibers before they are printed through the compression performed using a single screw extrution blending four replications with a speed of 45 rpm [6]. Results obtained in the form of spherical dots (Fig. 4 a). Once that is done the Compression colin P 300P. And continued with the cutting line with a mechanical test (Fig. 4 b)

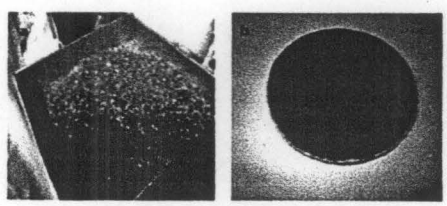

Figure 4 Results of extrusion (a) and compression (b).

Research on composite polipropillen filled with natural ligno-cellulosic fibers have been reported [6], [7], [8], but the research on composite polipropillen filled with rattan bark using HEM has not been done before. The results of

mechanical testing rattan bark fiber biocomposite and other biocomposites can be seen in Table 2.

Table 2 Mechanical properties of bio-composites comparisons Rattan Bark Fiber and Natural Fiber

Biocomposite filler	Tensile strength (Mpa)	Elongation at break (%)
Kenaf fiber	16. 85	2. 09
Acasia fiber	13. 03	1. 56
Water hyacinth fiber	14. 72	1. 75
Banana fiber	16. 18	1. 85
Coconut fiber	13. 61	1. 79
Flax fiber	17. 25	4. 50
Rattan bark fiber	18. 32	3. 93

As a result of the fibrous structure and strong hydrogen bonds. Cellulose has a high tensile strength. Thereby. greater the higher the cellulose content of the fiber tensile strength. Fiber-reinforced composites rattan bark and kenaf fibers exhibit high tensile strength compared with acacia fiber and coconut fiber. It's because the cellulose fiber content in rattan is also high ranging (37%-44%) and range in kenaf fiber is 45%-60% (Table 3).

The addition of rattan fibers into the composite lower elongation at break its properties compared with hemp fiber. This is due to the hydrophilic nature of the fiber that can absorb water. This condition will result in reducing the effects of physical bonding between the fiber and polypropylene surfaces [9]. Decreasing elongation at break properties on the bark of rattan fiber biocomposites showed that the bark of rattan fibers more rigid than the flax fibers.

Hydrophilic nature of the fiber rattan bark caused by its cellulose and lignin contains. Both of cellulose and lignin are rich in hydroxyl groups, they are very easy to absorb water through hydrogen bonds within the cell wall [10]. The content of cellulose and lignin in the rattan fiber is 37. 36% and 22:19%.

Tabel 3 Several Natural Cellulose Fiber Content [6], [11], [12], [13]

Fiber	Cellulose (%)
Kenaf	45-60
Banana	45-50
Rattan	37-44
Acasia	15-30
Coconut	14-20

Figure 5 shows a drive chain case produced by injection molding process, the product have been fitted to motor vehicles and and can compete with synthetic products from the automotive industry

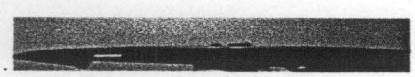

Figure 5 Motorcycle drive chain case

4 Conclusion

The usage of High Energy Milling (HEM) after a disc milling process can produce homogeneous rattan bark fibers with particle size until 16:22 nm with an optimum process time of 5 hours.

The results of mechanical testing tensile strength shows that fiber of bio-nanocomposite rattan skin was higher among the other natural composites (kenaf fiber, acacia, water hyacinth, banana, oil reservoir, hemp), but the value of elongation at break is still under bio-composite hemp.

Bio-nanocomposite can be applied to the drive chain case, but to produce the optimum mechanical properties of the bark of rattan fiber bio-nanocomposite, further research related to the method, the synthesis and usage of appropriate coupling agent are needed.

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