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Mechanical Properties of Ramie Natural Fiber with Shellac Natural Matrix for Green Composites

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Abstract: In this study, the properties of ramie fiber reinforced shellac composite were investigated. For this purpose strong and naturally available ramie fiber and shellac natural matrix were combined to form a fully degradable green composite. Ramie fiber was weaved in the form of balanced woven roving from long-continuous-neat and chemical treated fiber. The shellac was fabricated from albizzia insect secretion, cleaned, and liquefied to form an easy to use matrix material. Various fiber volume fractions of the composite plates were manufactured. The tensile test, flexural test and Charpy impact test then were performed to investigate the composite properties. Visual observation was performed using Scanning Electron Microscopy to observe the fracture surface, and optical microscopy for measuring matrix/fiber wettability. The result shows that shellac matrix can gives the same or even better properties than non natural matrices with ramie fiber reinforcement. The shellac also shows a good wettability to the fiber as shown by the low contact angle and clarified from the fracture surface.

Key words: *Ramie, Shellac, Wettability, Tensile strength, Bending strength*

1. INTRODUCTION

Many applications in engineering involving the use of glass fiber and other advanced fiber composites. These fibers have gained importance role in technical applications such as the automotive field, where high mechanical properties and dimensional stability should be combined with low weight. In the last decades, the need of natural material utilization for engineering application is increasingly draw attention among researchers due to the environmental awareness. This is resulting in increasing number of natural fiber utilization for composite materials with both, thermosetting and thermoplastics matrices [1–4]. The natural fiber is fiber extracted from natural resources, especially from organic substances, therefore, it is both biodegradable and renewable. The fiber has many advantages over man-made fiber not only in relation with environment friendliness, but also for technically reason such as high strength to weight ratio.

One of the strongest natural fiber is ramie fiber. Ramie (Boehmeria nivea), is a plant that grows well in area with warm climate, and rain fall yearly from 1500-3000 mm. The fiber was taken from stalk of ramie plant. The length ranges from 120 - 150 cm. Once it is first harvested, the fiber can be harvested again and again to more than 15 times. The first harvesting takes 5 months from planting. The next harvest can be done after 3 month or more. Therefore, producing ramie fiber only needs short time to cultivate.

For decades, the ramie fiber is used to make handi-crafts such as hand bags. It can be colored into various colors. In industrial usage, the fiber can be used as substitution of cotton, knitted to textile product. Naturally, this fiber is much stronger than cotton, so the resulted ramie textiles is stronger than cotton textiles.

However, most of the matrices used to make composite with ramie or other natural fiber are polymers produced from petroleum [1, 2], that are considered non-sustainable since the source is not renewable and non-biodegradable that in some extents will endanger environment.

Some biodegradable matrix, has been used for composite material [3, 4]. The biodegradable matrices can be classified into natural matrix and man-made matrix. One of the natural matrices is shellac, that still not used extensively for composite materials. This materials produced by insect that live on some plant, such as albizzia.

Combining the two natural materials, that are ramie fiber and shellac matrix, will give a fully biodegradable bio-composite. In this current study, the properties of rami fiber reinforced shellac were investigated. The investigation involves tensile, flexural, and impact testing of the composite.

2. MATERIAL AND METHOD

Ramie fiber, as reinforcement, is taken from ramie plant, which is cut, decorticated, degummed and alkali treated. The fiber then is weaved to the form a balanced woven sheet, as shown in Figure 1. The fiber properties, compared to those of other fibers shown in Table 1.

Shellac matrix is manufactured from secretion of