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The effect of crosslinker on mechanical and morphological properties of tropical wood material composites

Md. Saiful Islam [a,*], Sinin Hamdan [a], Md. Rezaur Rahman [a], Ismail Jusoh [b], Abu Saleh Ahmed [a]

[a] Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Sarawak, Malaysia
[b] Faculty of Resource Science & Technology, Universiti Malaysia Sarawak, 94300 Sarawak, Malaysia

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ABSTRACT

In this study, wood polymer composites (WPCs) based on five kinds of selected tropical wood species, namely Jelutong (*Dyera costulata*), Terbulan (*Endospermum diadenum*), Batai (*Paraserianthes moluccana*), Rubber (*Hevea brasiliensis*), and Pulai (*Alstonia pneumatophora*), were impregnated with methyl methacrylate (MMA) and hexamethylene diisocyanate (HMDIC) monomers mixture in the ratio of 1:1 for composite manufacturing. All these tropical wood reacted with hexamethylene diisocyanate and crosslinked with MMA which enhanced the hydrophobic (restrained water) nature of wood. The vacuum-pressure method was used to impregnate the samples with monomer mixture. The monomer mixture loading achievable was found to be dependent on the properties of wood species. Low loading was observed for the high density wood species. Mechanical strength of fabricated wood polymer composites (WPCs) in term of modulus of elasticity (MOE) and modulus of rupture (MOR) were found to be significantly improved. The wood–polymer interaction was confirmed by Fourier transform infrared (FTIR) spectroscopy. Morphological properties of raw wood and WPC samples were evaluated by scanning electron microscopy (SEM) and XRD analysis and an improvement in morphological properties was also observed for WPC.

1. Introduction

Structural wood has always been, and continues to be, a very important and versatile material with many uses because of its very aesthetically pleasing character. But wood has some drawbacks such as high moisture uptake, biodegradation, and physical and mechanical property change with environmental factors [1]. These troublesome inherent properties of wood can be minimized by appropriate chemical treatment such as the formation of wood polymer composite (WPC) [2]. The presence of hydrophilic hydroxyl groups (—OH) in the wood components is the main factor responsible for the negative properties. Wood attracts moisture through hydrogen bonding, making it physically unstable. The physical and mechanical properties of wood can be improved by using an impregnation technique with suitable chemicals that can react with cell wall components [3]. The improvement in properties of wood may also be enhanced by preparing wood polymer composites (WPC) with different monomers [4–7]. Manufactured WPC generally exhibits effective dimensional stability and excellent mechanical properties [8,9]. WPCs can also improve many properties of solid wood such as surface hardness, toughness, abrasion resistance, moisture exclusion and weather resistance. In general, the improvement in property can be attributed to the polymer content, which is dependent on the type of wood, the polymer and processing technology applied. The main factors influencing the WPC properties of wood are density, moisture content, direction of the grain, and the physico-chemical composition of the cell wall of the wood. In the literature, it can be seen that the heavy hardwoods species gain lower amount of monomer than those from the medium, light hardwoods species [10]. The lower monomer loading of hardwoods can be ascribed by their some inherent properties such as high density and specific gravity including internal vessel diameter, the number of vessel percent per unit area, and its high extractive. Therefore, it has been established that the properties of WPC depend on the wood species and the physical and mechanical properties of composite increases with the increases of monomer loading [11].

Recently, considerable interest has been manifested in wood impregnation with a variety of monomers such as styrene, epoxy resins, urethane, phenol formaldehyde, methyl methacrylate (MMA), vinyl or acrylic and their combination to change the specific properties of WPC [12,13]. However, it has been established that most monomers do not form bonds with hydroxyl groups of the wood component. They simply bulk the void spaces within the wood structure [14]. It can therefore be deduced that if bond-

* Corresponding author. Tel.: +60 149922251.
E-mail address: msaifuli2007@gmail.com (M.S. Islam).

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