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Potential Fungus surface resistance of the silica/acrylic coated leaves waste composite

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Abstract. The composite coated by some materials coaters have been made. This coating was done to isolate the fungus possibly growing on the composite. The composite was made from a mixture of teak leaves waste and polyurethane polymer using a simple mixing method; then the mixture was pressed at a pressure of 3 metric-tons for 15 minutes. The composite produced then was coated with acrylic only and acrylic-silica using spray method. The coated samples then were characterized using scanning electron microscopy (SEM) to determine the surface pores. Further, it was obtained the average surface pore size of acrylic coater is 1.24 µm, while the acrylic-silica pore forms an oval shape with a length and a width of 0.75 µm and 0.38 µm, respectively. In comparison with the fungus size of 2-7 µm, it can be concluded that the composite is proper as home appliance application.

Introduction

The wood demands are increasing for several decades as people growth. It challenges the researcher and industrialist to develop a material replacing the rare woods, and one of the ways is through the composite engineering producing a lignocellulosic material having properties like the woods [1-6]. These composites have been made from natural fibers and agricultural wastes mixed with a polymer to strengthen bonding with pressing technology [7-8].

Some research relating to the lignocellulosic composite have been done, such as Mango leaves waste composite [9], composite using cellulose fibers [10], tea waste composite [11], and peanuts-shell composite [12]. However, most of them have not performed the safety aspect of its usage yet, especially in handling the fungus that enables grows on the composite as the hygroscopic environment. Further, as a hygroscopic environmental condition where the water easily penetrates into the composite network, the composite will be targeted for the growth of fungi and other biological agents [13-14]. Therefore, it is very important to ensure the fungus that may grow on the composite must be isolated, and one of the ways is by a coating process.

Several works of composite coatings have also been done, such as Iswanto *et al.* [8] that have treated liquid paraffin, liquid silicone and waterproof coating on composites. Further, Lesar and Humar [15] used waxes to coating on wood surfaces and to know their resistance to fungi. However, these studies have not examined the possibility of fungus resulted from the composite passing to the surface, regarding the contents of the leaf waste usually produce fungus.

In this works, we have made a polyurethane/teak leaf waste composite coated with some material coaters. By using the coating process, the composite produced has properness and safety from fungus

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to be used as several home appliance. We have also measured the surface pores to ensure that the fungus possibly growing cannot pass to the surface.

Material and Methods

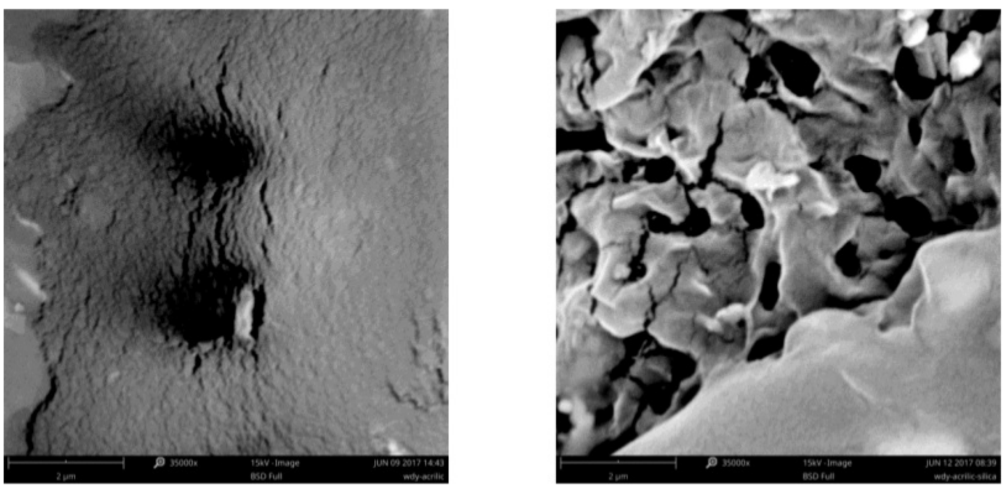
The leaf waste used is Javanese teak leaf waste, while polyurethane, acrylic, and silica were purchased from Indrasari, Semarang, Indonesia.

For first, polyurethane was mixed with crushed-teak leaves at the certain fraction. The mixture was stirred until homogeneously and then pressed at 3 metric tons pressure for 15 minutes to produce polyurethane/teak leaf waste composite. The composite then was coated using spray method with several material coaters, including acrylic only and acrylic-silica, with the mass of silica and acrylic is 5 g and 30 g, respectively. The mixing process of silica and acrylic was done using magnetic stirrer for 5 minutes to ensure the mixture is homogeneous. The spray method was operated with a pressure of 10 bars.

Scanning electron microscopy (SEM) test was performed to determine the average pore magnitude of the composite surface [16]. This pore then was compared to the several sizes of fungi to judge closure performance of the coater to the fungi that may grow from the teak leaf waste inside.

Result and Discussion

Cellulose and lignin contents in the teak leaf waste can trigger fungi growth when there is water infiltrating into the composite as a hygroscopic environment. The coating treatment is to prevent water to insert into the composite and also ensure the composite has resistance to fungi grown from teak leaf waste inside.



a) b)

Figure 1. SEM image of composite for a) acrylic, b) acrylic-silica coatings

Using SEM measurement (Figure 1), it was obtained the composite surface pore size as shown in Table 1. For the composite coated by acrylic only, the average pore size is 1.24 μm with very rare distribution and has a ball shape (Figure 1(a)). This pore may occur due to an interaction between acrylic and the teak leaf waste particle underneath. As this interaction, some of the acrylic chains are attracted inside and forms some pores. This suggestion is based on the acrylic's active group, i.e., the vinyl group attracted by some particle, especially teak leaf waste particle on the composite surface [9,16]; Masturi et al., 2017). Meanwhile, the silica/acrylic coater tends to form more oval shapes having average length and width of 0.76 µm and 0.38 µm, respectively (Figure 1(b)). The smaller size of the pore is suggested due to stronger interaction occurs between acrylic and silica than that of acrylic and teak leaf waste, especially between slightly electropositive silicon and electronegative oxygen of acrylic's vinyl group to form dipole-dipole interaction, while the large density of the pores is due to the strong interaction. However, we have not examined this interaction yet in this work.

Table 1 shows both pore sizes of acrylic and acrylic-silica are fairly small if compared to some wooden fungi having average pore size 3-7 µm [17]. It means that the fungus possibly growing on the polyurethane/teak leaf waste composite cannot get out passing the pores and further may stay for a long time under the coater to die.

Table 1. The pore size on the composite surface for several materials

Coating materials	Pore size (μm)
Acrylic	1.24
Acrylic/silica	Length = 0.76 , width = 0.38

As the pore size above, it can be concluded that the composite produced is safe as home appliance raw material in competing for the woods to reduce the woods usage and deforestation.

CONCLUSION

We have synthesized polyurethane/teak leaves waste composite coated with acrylic and acrylic-silica. The surface morphology of the acrylic coated and acrylic-silica coated composites have a pore size of 1.24 µm and 0.38-0.76 µm, respectively. These pore sizes are relatively smaller compared to wooden fungi having average size 3-7 µm. It means so that the composite is reasonably safe from the fungi may grow from the teak leaf waste inside, and further, it can be used as home appliance material competing for the woods.

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