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Comparative Study of Epoxy Composites Reinforced with Kenaf Fiber and Different Types of Microparticles

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Abstract. Reinforcement of both fibrous and particulate materials can improve composite properties for various applications, such as biomedical applications. The alkali-treated kenaf fibers and (SiO_2, bentonite, and $CaCO_3$) microparticles 400 mesh in size reinforce the epoxy matrix for hybrid composites. The bending and impact properties of hybrid composites, as well as their water absorption, are compared. The hybrid composites were prepared in a compression mold using a hand lay-up technique at 100°C for 20 – 50 minutes consisting of 28 vol.% of short kenaf fibers ~5 mm in length, 2 vol.% of each type of microparticle, and 70 vol.% the epoxy resin. The flexural and impact properties of kenaf/silica/epoxy composite indicated the highest flexural strength (58.37±3.9 MPa), flexural modulus (4.68 ± 0.17 MPa), and impact strength (7.49 kJ/m^2). The addition of the microparticles reduced water absorption in the composites. The water absorption of kenaf/silica/epoxy composite appeared to be stable for immersion time near 216 hours. Other microparticle-filled composites did not show this pattern. The incorporation of silica microparticles to the kenaf/epoxy composite potentially enhanced the mechanical properties of the composite, with the expectation of using it to be developed for biomedical composite material.

Introduction

Studies on the characterization of epoxy composites properties improved with fibrous and particulate fillers have been reported, especially synthetic fibers and various organic and inorganic particulates [1-6]. The type of both fibrous and particulate fillers used affects the composite properties. The properties of composite material effectively change by changing the filler types. Thus, they can be developed for both medical and non-medical uses.

Epoxy is a thermoset matrix widely used in some applications, including automotive [2], structural material, building [3, 4], and biomedical [5, 6]. It has better mechanical properties than other thermoset polymers, and it can bind to fiber very well as reinforcement. The type of fillers selected, the manufacturing process, and the sensitivity and toughness of filler materials are considered when designing the composite materials.

Natural fiber-based composites, including kenaf fiber-based composites, can be used to manufacture prosthetic leg sockets [7]. The prosthetic socket material made of natural fiber-based composites could provide some advantages, such as being lightweight, cost-effective, and long-lasting [8]. Kenaf fiber can be processed as a high-impact composite to replace glass fiber as one of the layers in the fabrication of prosthetic sockets [9]. The socket is anatomically formed and usually made of a plastic laminate material of acrylic resin with glass and/or carbon fiber reinforcement [10]. However, glass fiber has a potential health hazard to humans and the environment [11], and carbon fiber is expensive.

Therefore, modifying the epoxy composites reinforced with kenaf fibers and inorganic particles to replace glass fiber is a good challenge. Natural fibers and minerals particles are the abundantly available natural resources, such as in Indonesia. Even though they are well-known for their potential for innovative and advanced functional materials, their applications still need to be enhanced. The