

Effects of Immersion Time on the Indium Zinc Oxide Coated on Non-woven Kenaf

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ABSTRACT – The coating of indium zinc oxide (IZO) on non-woven kenaf was studied by experimenting the effect of immersion time in IZO solution on non-woven kenaf via immersion method. Kenaf samples were immersed into IZO solution at five different periods of time before dried and annealed at 150°C. The final products of IZO coated fiber were analysed based on its morphological and elemental studies. It was found that as the immersion time increased, the coating surface turned out to be coarser and uneven which also led to surface crack. However, the coating surface resulted in smooth appearance at a specific range of time of 10-20 minutes. The presence of transparent IZO coating on kenaf was supported by the elemental analysis results by energy dispersive X-ray spectroscopy (EDS) that proved the presence of zinc and indium elements, even though the indium element was not observed in the EDS spectrum due to its minimal amount.

1. INTRODUCTION

Natural fiber or plant fiber is a non-conductive material. Its broad potential usage has drawn much attention amongst researches in various applications including electrical application. The idea of adopting natural fiber as conductive material has led to development of natural fiber conductive material in various application such as electromagnetic interference shielding material [1,2]. Various techniques have been studied to integrate conductive element into natural fiber material and the most popular technique is conductive coating technique.

Dip coating process is one of the most economical and simplest technique that is applied in many industries as a way to deposit or coat any substrate including metal, polymer, ceramic and fibrous materials. As for fibrous material, dip coating process can be performed by several different methods including solution dip coating, sol gel dip coating, spin-assisted dip coating, multi-layer dip coating and vacuum assisted dip coating [3]. Immersion is one of the steps involved in dip coating process. Thus, the aim of this study is to evaluate the effects of immersion time on the properties of IZO coated kenaf fiber.

2. METHODOLOGY

The non-woven kenaf was supplied by Lembaga Kenaf and Tembakau Negara. The conductive non-

woven kenaf samples were produced by different dipping times (10, 20, 30, 40, 50 minutes).

Initially, coating solution was prepared by diluting 0.1M zinc acetate dihydrate in ethanol and was stirred on magnetic stirrer at 25°C for 1 hour. Then, 5.0 wt% of indium (III) chloride was added into the solution and continued stirring at 75°C for another hour while deionized water was dripped into the solution until it turned to clear solution. Meanwhile, non-woven kenaf was chemically treated by 6% of sodium hydroxide (NaOH) for 24 hours and dried for another 24 hours at 70°C. The coating process was carried out after both kenaf fiber and solution had been successfully prepared. The non-woven kenaf fiber was immersed into the solution according to specific times. Each sample was dried and then post-annealed at 150°C for 4 hours. The coated samples then were ready to be analysed.

The characterizations involved in this study were morphological and elemental analyses, in order to study the effect of dipping time on the IZO coating on non-woven kenaf. Scanning electron microscope (SEM) and energy dispersive X-ray spectroscopy (EDS) were used to evaluate the coating morphology and analyze the elements present on the coated kenaf fiber, respectively.

3. RESULTS AND DISCUSSION

The SEM images obtained from the uncoated kenaf and kenaf coated at different periods of immersion time are illustrated in Figure 1. It can be seen that as the immersion time increases, the fiber surface becomes coarser which is most likely due to the increased precipitates of IZO. At immersion time of 10 and 20 mins, the coating layers appear as smooth coating surface as shown in Figure 1(b) and (c), almost similar to the untreated fiber surface in Figure 1(a). Meanwhile, at immersion times of 30, 40 and 50 mins (Figure 1(c), (d) and (e)), the coating seems to form uneven coating surface and at 50 mins dipping time, cracks start to appear, which might be attributed to excessive deposition of IZO. Similar finding has been reported by Rahaman et al. [4], in which the found that as deposition time increased, the thickness of coating increased and at extended deposition time the coating adherence to fiber became weaker and resulted in crack formation. These coating surface qualities will influence the electrical properties of the kenaf, since the thickness of the coating is one of the crucial parameters [5].

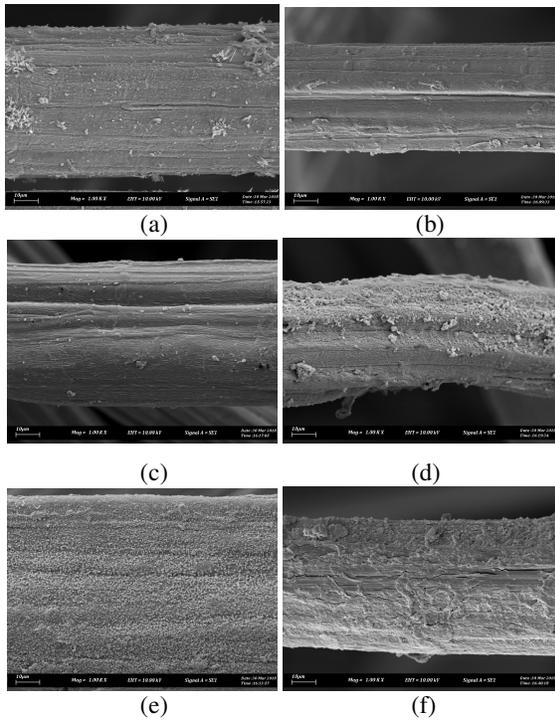


Figure 1 SEM images of (a) raw kenaf fiber and coated kenaf fibers at different immersion times of (b) 10 min, (c) 20 min, (d) 30 min, (e) 40 min and (f) 50 min at 1000x magnification

The EDS spectrum of the coated kenaf fiber is shown in Figure 2, while the weight and atomic percentages of the elements are tabulated in Table 1. From Figure 2, the presence of zinc is clearly observed in this elemental analysis. Other elements such as C, O and Pt are also observed. The C and O are attributed to the organic elements of kenaf fiber, while Pt is due to platinum thin coating applied prior to EDS measurement. The indium element does not appear in the EDS spectrum due to its minimal amount of 5 wt%, which is equivalence to only about 0.1 - 0.2 at%, as calculated from Table 1. However its presence was confirmed through the EDS element mapping. The relatively small atomic percentage Zn compared to C and O elements in Table 1 reflects the thinness of the coating in comparison to the kenaf fiber.

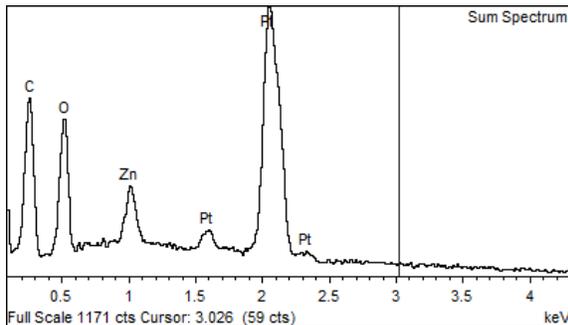


Figure 2 EDS spectrum of the coated kenaf fiber via 20 min immersion time.

Table 1 Weight and atomic percentages of each element as detected by EDS

Element	Weight Percentage (%)	Atomic Percentage (%)
C	43.41	57.63
O	38.00	37.85
Zn	18.54	4.52

4. CONCLUSION

Based on the results obtained, it is concluded that indium zinc oxide can be successfully coated on kenaf fiber via simple dip coating technique. The presence of zinc and indium elements on the kenaf surface has proven that simple dip coating is an applicable technique for depositing indium zinc oxide on non-woven kenaf as a conductive coating. Besides, the parameter of dipping time does influence the IZO coating surface quality, and further study on its electrical properties can be developed.

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