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# Tensile Properties and Morphology of Oil Palm Empty Fruit Bunch Regenerated Cellulose Biocomposite Films

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**Abstract**

The regenerated cellulose (RC)biocomposite films were prepared using casting method where oil palm empty fruit bunch (OPEFB) and microcrystalline cellulose (MCC) were dissolved in N-dimethylacetamide/lithium chloride (DMAc/LiCl)solution. The increasing of OPEFB contents up to 2 wt% increased the tensile strength and modulus of elasticity of RC biocomposite films while the elongation at break decreased. However, at 3 and 4 wt% of OPEFB content, the tensile strength and modulus of elasticity decreased with increases OPEFB content, but elongation at break increased. The increment of tensile strength and modulus of elasticity at 2 wt% is due to the OPEFB fiber that partially dissolved and dispersed with the OPEFB matrix. The morphology studies illustrate that at 2 wt% of OPEFB content of biocomposite films surface consists less voids and agglomerations than at 4 wt%. This can be considered the RC filler was partially dispersed with the RC matrix in the biocomposite films.

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*Keywords:*Regenerated cellulose; Oil palm empty fruit bunch; Biocomposite films

## 1. Introduction

In recent years, more attentions are focus on renewable resources in producing desirable products whereby its characteristics and properties showed potential as substitutions to the traditional petrochemical and fossil fuels[1, 2]. Cellulose which can be found abundantly on Earth is currently known as one of the most promising natural

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resources which are used in many applications[3-7]. These natural resources cover a variety of properties such as biodegradable, biocompatibility and also cheap with price and are often used in the production of paper and packaging. Besides that, cellulose is also used as bio-based material in applications that revolve around films, membranes and food casings[2].

Recently, many researchers conducted studies to understand more about the new type composite which is based of cellulose known as all cellulose composite where the reinforcement and matrix constituents are from the same polymer form which is the cellulose. The products are called self-reinforced polymeric materials (SRPMs)[8]. The concept of this new system happened when a part of the polymer fiber is melted followed by recrystallization into a matrix that further bonds the fibers together and forms an interface[9]. Nishino et al.[10] were among to study the process where Kraft fiber was fully dissolved followed by the regeneration in the presence of ramie fibers.

Regenerated cellulose or in other word man-made cellulose is a chemical dissolution of insoluble natural cellulose followed by the recovery of the material from the solution. The regenerated cellulose fibers have been made according to various processes yielding with a wide range of mechanical properties[11]. The concept in cellulose regeneration involved removal of solvents by a coagulant and removal of the coagulant through evaporative drying. For example, when some parts of the cellulose began to swell prior to dissolving in a particular solvent this swollen cellulose will transform into the matrix phase. This matrix phase then covered the reinforcement or the non-dissolved part of the cellulose. Finally, the solvent used in partial cellulose dissolution is removed by using a coagulant like water before drying [12].

Note that not all solvents can be used to dissolve cellulose. Some of the popular or commonly used solvents to dissolve cellulose are N-dimethylacetamide/lithium chloride (DMAc/LiCl)[13], and N-methylmorpholine-N-oxide (NMMO)[14,15]. Some studies involved the use of DMAc/LiCl such as Zhao et al.[16] reported that the nanocomposite films showed good optical transparency and remarkable mechanical properties. In addition to that, Govindan et al.[17] conducted a researched on preparation of regenerated cellulose whereby the dissolution of microcrystalline cellulose (MCC) using DMAc/LiCl has improve the tensile strength and modulus of elasticity of the biocomposite films.

Oil palm (Elaeisguineensis) which was originated from West Africa has grown widely in tropical area of Southeast Asia such as Malaysia[18]. The palm oil industry business is considered as one of the largest agriculture businesses in Malaysia and the production of palm oil leads to a vast biomass lignocelluloses residues[18, 19]. These wastes can be in form of oil palm empty fruit bunch (OPEFB), oil palm fiber and other lignocelluloses wastes[20, 21]. The compositions of OPEFB are cellulose, hemicellulose and lignin. The high content of cellulose in OPEFB leads to production of variety of applications[22]. The cellulose from OPEFB can be used to be regenerated into the production of biocomposite films[23].

This research was focus on the study of dissolving natural resource which is OPEFB with DMAc/LiClto produce regenerated cellulose biocomposite films. The objective of this study is to study the effect of OPEFB contents on tensile and morphology of regenerated cellulose biocomposite films.

## 2. Experimental

### *2.1. Materials*

Oil palm empty fruit bunch (OPEFB) was obtained from Malaysian Palm Oil Board (MPOB) Bangi, Selangor. The OPEFB fiber was ground using ball mill into powder form and sieved. The average particle size of OPEFB was 35 μm, which was measured using Malvern particle size analyzer. Microcrystalline cellulose (MCC) with particle size of 50 μm was supplied by Aldrich. Sodium hydroxide (NaOH), ethanol ($C_3H_3OH$), and sulfuric acid ($H_2SO_4$) were purchased from HmbG® Chemicals. Sodium chlorite ($NaClO_2$) was supplied by Sigma-Aldrich. N,N-Dimethylacetamide (DMAc) was purchased from Merck. Lithium chloride (LiCl) was supplied by Across, Belgium and acetic acid was obtained from BASF Chemical Company.

### *2.2. Pre-treatment of OPEFB*

OPEFB was treated in 4 % NaOH solution at temperature of 70°C for 3 hours under stirring conditions. This procedure was repeated three times. Then, each treatment of treated fillers was filtered and washed with distilled