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Enhancing Current Density and Specific Capacitance through Tensile TOBC/PPY Nanocomposites

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Abstract— The researchers developed a bio-composite film material that serves as a substitute for metal. The materials used are TEMPO ((2,2,6,6-tetramethylpiperidine-1-oxyl)), Bacterial Cellulose, and Polypyrrole (Ppy). This research aimed to increase the current density and specific capacitance values of the material using the drawing method. Composite nanomaterials are made by oxidizing BC (Bacterial Cellulose) with TEMPO. The resulting TOBC (TEMPO Bacterial Cellulose) material was mixed with Ppy using the in situ method. The mixture is then drawn wet—measurement of current density and capacitance using Cyclic Voltammetry (CV) Testing. The results of the current density and specific capacitance increased by 542.74% and 754.79% after drawing the nanocomposite material. It is directly proportional to the effects of characteristic testing, which includes SEM, XRD, and FTIR. As a result of the withdrawal of the polypyrrole, it will be more evenly distributed in the composite material, absorbing and coating the nata de coco. When the TOBC/Ppy fibers are straighter and denser, they achieve higher current density and capacitance values, as concluded by the researchers.

Keywords: Bacterial Cellulose, Composite nanomaterials, Tensile method, Wet Tensile, Even distribution.

1. Introduction

Acetobacter xylinum is used to ferment coconut water, producing nata de coco. Acetobacter xylinum breaks down the glucose in coconut water into carbon, which is subsequently transformed into cellulose fiber during Nata de Coco production [1][2]. Under the influence of Krebs cycle enzymes, acetobacter may quickly oxidize acetic acid to carbon dioxide and water. As a result, they cannot oxidize acetic acid, in contrast to other genera such as Gluconobacter [3][4]. Bacterial cellulose fiber also has a high tensile strength and is corrosion-resistant [5]. Often referred to as cellulose fiber (BC), bacterial cellulose has several benefits, including low cost and environmental friendliness. Regarding mechanical strength, the bacterial cellulose fibers in this study outperform cellulose fibers made from plants [6]. The bacterial cellulose must be mixed with a substance with high electrical conductivity to form a conductive membrane.

Composite materials are innovative materials that combine two or more materials with exceptional properties. To create composite materials with electrical characteristics, we conduct material mapping to identify substances with both solid mechanical and electrical properties. We aim to develop composites that can replace metals in various applications.

Innovative materials, known as composites, combine two or more materials with remarkable qualities. We perform material mapping to find materials with solid mechanical and electrical properties and then create composite materials with electrical characteristics. Our goal is to develop composite materials that can take the place of metal in a variety of uses.

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