



An overview of feasibilities and challenge of conductive cellulose for rechargeable lithium based battery



Sarute Ummartyotin^{a,*}, Hathaikarn Manuspiya^b

^a Department of Physics, Faculty of Science and Technology, Thammasat University, Patumtani 12120, Thailand

^b The Petroleum and Petrochemical College, Center of Excellence on Petrochemical and Materials Technology, Chulalongkorn University, Bangkok 10330, Thailand

ARTICLE INFO

Article history:

Received 27 September 2014

Received in revised form

29 April 2015

Accepted 6 May 2015

Keywords:

Cellulose

Conductive cellulose

Rechargeable lithium based battery

ABSTRACT

The interest in cellulose and its modification has been exponentially increasing. The outstanding properties of cellulose were evident due to high stiffness, high chemical resistance, low co-efficient of thermal expansion as well as high aspect ratio. Up to the present time, in order to support clean technology, the use of cellulose has been extensively gained many interests for many sectors of research. Cellulose was therefore modified to enhance its conductivity. The example was due to design cellulose based composite with conductive polymer and doping on small amount of metallic particle and active carbon. In this review, the objective of article was focused on the modification on conductivity of cellulose. The application on conductive cellulose was therefore presented in rechargeable lithium based battery.

© 2015 Published by Elsevier Ltd.

Contents

1. Introduction	205
2. Conductive cellulose preparation	205
2.1. Conductive cellulose modification	205
2.2. Conductive materials for conductive cellulose preparation	207
2.2.1. Conductive polymers and derivative	207
2.2.2. Metallic particle and derivatives	207
2.2.3. Active carbon	208
3. Structure of conductive cellulose	208
3.1. Binary blend	209
3.2. Doping process	209
4. Conductive cellulose for lithium based energy storage device	209
5. Remaining challenge	210
5.1. Long term stability	210
5.2. Reproducibility	211
5.3. Characterization the dispersion state	211
6. Conclusion and future outlook	211
References	211

* Corresponding author. Tel.: +66 2 564 4490; fax: +66 2 564 4485.

E-mail address: sarute.ummartyotin@gmail.com (S. Ummartyotin).

1. Introduction

Due to the environmental concern over the use of petroleum and petrochemical based product, this century has witnessed remarkable achievements in Green technology by means of the development on materials science to bio-based composite. Therefore, many research activities regarding bio-based materials have been extensively developed such as cellulose [1–3], chitin-chitosan [4–6], polylactic acid (PLA) [7,8], polybutylene succinate (PBS) [9] as well as natural rubber (NR) [10]. The purpose on the use of bio-based product and process was due to environmental concern. In order to support Green technology, engineering and technology should be preferably employed product and process that minimize on hazardous substance. Moreover, another aspect was involved on value-added concept. Bio-based material was considered as waste and it can be supplied as raw material for economical reason [11,12]. For example, cellulose was considered as raw material for paper-making process. Antimicrobial properties in active packaging were employed chitosan based composite. The raw material for bio-based plastic for food and beverage was involved on polylactic acid. It can be categorized into 2 different methods; the top-down approach was referred the process that biomass is subjected to high shear forces in order to create nano-fibrillated cellulose [13] while the bottom-up approach was related to utilizing the biosynthesis of bacterial. The most effective bacterial specie was due to *Acetobacter Xylinam* [14]. From the fundamental point of view, it was important to note that cellulose was considered as the most abundant naturally occurring resource. Improvement on properties of cellulose was therefore considered as the interesting challenge for many applications. Not only availability and low cost of expenditure but also the concept of Green technology can be overcome. The role of cellulose can be employed in many applications. For example, cellulose exhibits high stiffness and high aspect ratio [15]. One of outstanding applications of cellulose was therefore encouraged as reinforcement part in composite. Mechanical properties can be consequently enhanced. If application area was related to electronic device [16–18], cellulose also present the excellence on dimensional stability [19], while if application related to food industry, it also present the excellence on water absorption ability [20]. It is remarkable to note that electronic device was generated heat during operation and food and beverage product can be highly absorbed moisture, respectively. Moreover, the role of cellulose was versatile in many engineering sectors. It included infrastructure such as building wall and bridge, automotive part such as interior and exterior console [21]. In medical and pharmaceutical research, the role of cellulose was employed; it called tissue engineering for bone repair, skin recovery technology as well as scaffold materials [22,23], whereas in electronic device, bio-based materials can offer significant feature as flexible substrate for organic light emitting diodes.

Up to the present time, the role of cellulose can be extent to electronic device society. One of interesting applications was employed as flexible substrate [16,24]. For electronic device, it was commonly fabricated by using glass sheet as substrate. Although, the use of glass sheet as substrate provides significant properties in terms of surface smoothness and dimensional stability, it offered brittleness. Currently, the use of plastic based material has been employed due to additional feature of flexibility and cost of raw materials. However, the use of plastic based electronic was limited due to low thermal resistance and low elongation at break if roll to roll (R2R) [25,26] technique was employed to fabricate electronic circuit. To overcome these limitations, it can be employed cellulose based substrate. Cellulose can be employed as flexible substrate due to excellent coefficient of thermal expansion, chemical resistance and mechanical properties [27–29].

In this review, up to the present time, numerous efforts have been extensively developed on electronic device. The development of electronic device has led to be smaller and smaller [30,31]. This evolution answers to the increasing miniaturization, high density of components with a high-reliability of device. For electronic device, lithium based battery has been widely used in many portable devices such as cell phone, laptop and camera due to the advantage of high energy density and long cycle life [32,33]. Lithium based battery was defined as disposable battery that lithium based compound was employed as an anode [34]. It stands apart from other battery due to high charge density and high cost per unit, depending on design and chemical compound. In general, it can produce voltage from 1.5 to 3.7 V [35,36]. From the viewpoint of cellulose for electronic, it was remarkable to note that cellulose has been chemically and physically modified for flexible substrate or smart paper for electronic device. To integrate with lithium base materials can be effectively performed for being developed lithium based battery on cellulose [37,38]. Many forms of lithium such as lithium-ion, lithium based oxide and lithium based conductive polymer composite has been extensively investigated for flexible feature of battery [39–41]. The incorporation of cellulose and lithium based compounds can be effectively benefited due to high flexibility, low coefficient of thermal expansion, high chemical resistance. As a result, it gained the interest on novel types of flexible battery for electronic device.

The objective of this review article was to present the state-of-art cellulose and its modification for flexible lithium based battery. Cellulose has been chemically and physically modified for its conductivity. After that, fundamental background of conductive cellulose for lithium based battery was discussed.

2. Conductive cellulose preparation

2.1. Conductive cellulose modification

In the viewpoint of energy storage device, it was important to note that significant efforts have been extremely paid attention to be researched. Due to chemical structure of cellulose which consisted of three positions of hydroxyl group, chemical modification can be therefore conducted in order to enhance the electrical conductivity of cellulose [42–45]. Due to the outstanding properties of cellulose including mechanical properties and thermal resistance, many approaches on application of cellulose was therefore developed [46,47]. Figs. 1 and 2 exhibit the structural properties and morphological properties of cellulose, respectively.

In order to realize on the importance of cellulose, this scenario was being encouraged to improve the role of cellulose in energy storage device as well as the utilization in power system. Cellulose has been extensively developed on its conductivity for 30 years ago [12,48–51]. One of attractive ways of conductive cellulose modification was considered on the incorporation with conductive polymer. In general, conductive polymer exhibits high potentiality to aggregate and ease of process-ability [51,52]. It was extremely improved and studied for many applications. One of attractive applications was involved on electro-active polymer; it effectively provided many functionalities such as dielectric and piezoelectric [53,54]. Moreover, application of conductive polymer was enrolled

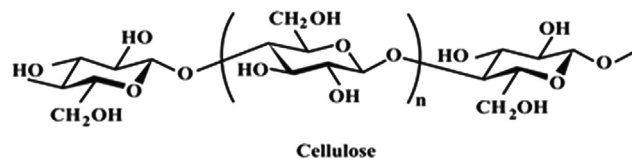


Fig. 1. Structure of cellulose.

Download English Version:

<https://daneshyari.com/en/article/8116028>

Download Persian Version:

<https://daneshyari.com/article/8116028>

[Daneshyari.com](https://daneshyari.com)