Dextran from *Leuconostoc mesenteroides*-doped ammonium salt-based green polymer electrolyte

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Abstract. Biopolymer electrolytes based on dextran from *Leuconostoc mesenteroides* doped with ammonium nitrate (NH₄NO₃) are synthesized via a solution cast method. Fourier transform infrared analysis is used to determine the complexation between cation from the salt with functional groups of dextran. The ionic conductivity of undoped dextran film at room temperature is identified as (8.24 ± 0.31) × 10⁻¹¹ S cm⁻¹. A conductivity of (3.00 ± 1.60) × 10⁻⁵ S cm⁻¹ is achieved with the inclusion of 20 wt% NH₄NO₃ to the pure dextran film. The conductivity at a high temperature of the electrolyte obeys Arrhenius theory. Field emission scanning electron microscopy results show that the highest conducting sample has a porous surface. Results from the dielectric study show a non-Debye characteristic.

Keywords. Biopolymer; dextran; ammonium nitrate; dielectric; ionic conductivity.

1. Introduction

Biomaterials and natural products are good candidates to be used in research activities due to awareness of global crisis. Many researchers have incorporated biopolymers as the polymer host in electrolytes due to its magnificent characteristics, such as easy film formation and compatibility with a wide range of salts and solvents [1]. Furthermore, most biopolymers can be sustainably acquired from a large range of natural resources. Above all natural polymeric materials are eco-friendly and thus their use for electrolyte applications reduces harm towards human health and environment [2, 3].

Biopolymers are extracted from a wide range of resources such as cellulose derivatives, chitosan, carrageenan, pectin, starch and lignin [4-10]. These polymers possess a lone pair electron of the heteroatom such as nitrogen or oxygen and hence ionic dopant can be solvated [11]. Dextran is one of the non-toxic and biodegradable polysaccharides obtained from the reproduction of bacteria *Leuconostoc mesenteroides*. Dextran possesses a linear polymer backbone with primary linkages of 1,6-α-D-glucopyranosidic [12]. Typically, dextran is used in the medical field as a drug carrier, substitute of blood, in bone curing and plasma modification. In the structure of dextran, the presence of hydroxyl group ensures the polymer to be used as an ionic conductor [13].

There are various types of salt that have been used as ionic dopants e.g., lithium, sodium, silver and ammonium salt. However, some alkali metal salts such as lithium and sodium salts have disadvantages such as reactive with H₂O and thermally unstable [14]. In addition, polymers in lithium-based polymer electrolytes require rich electronic functional groups for the conduction of Li⁺ ions [15]. The solvents for inorganic salts such as sodium iodide and potassium iodide are limited [16]. Ammonium salts show a high conductivity value. The use of ammonium salt is also helpful to avoid the use of expensive lithium metal as an electrode in battery applications [17]. In this work, dextran and ammonium nitrate (NH₄NO₃) have been used as a polymer host and an ion source, respectively.

2. Methods and procedures

2.1 Preparation of samples

Dextran powder (2 g) (Sigma-Aldrich) was poured in 50 ml of 1% acetic acid at room temperature for 40 min. After the dextran was completely dissolved, different concentrations of NH₄NO₃ (SYSTEM) were included in the solution of dextran. The solution was poured into Petri dish. The sample was left to dry at room temperature. The formed films were then placed in a desiccator. The compositions for the electrolytes are shown in Table 1.