Renewable resource using cellulose derivatives by melt process

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Abstract. Melt processable plasticized cellulose diacetate (CDA) was prepared using triacetin (TA) as a plasticizer and its mechanical properties were characterized. The processability of the plasticized CDA was further enhanced by using a small amount of epoxidized soybean oil as a secondary plasticizer. The glass transition temperature of the plasticized CDA was observed at 50°C lower than that of the virgin CDA and the incorporation of 5 % of ESO also resulted in an additional 20°C decrease in the Tg value. In order to obtain practical processing conditions, a plasticizer content of more than 20 wt % should be used.

Introduction

Cellulose is the most abundant naturally occurring macromolecular material on the surface of the earth. Cellulose usually occurs in the cell walls of green terrestrial and marine plants. For millennia, it has provided mankind with a functional, low cost and renewable raw material. As a biomaterial, cellulose can be converted into a wide range of derivatives with tailored properties for a variety of applications. Cellulose is a polymer consisting of D-glucopyranose units, in which the monosaccharide residues are linked by β-(1→4) bonds and the chains are not branched. The β-(1→4) linkage results in a rigid or semi-rigid chain polymer that is ideally suited for forming fibrils via inter and intra-chain hydrogen bonding between the –OH groups on the glucose residues. Because of the high degree of strong hydrogen bonding, cellulose is insoluble in water and organic solvents. These hydroxyl groups in cellulose can undergo any of the chemical reactions that are common to all primary and secondary alcohol groups, such as esterification, nitration, etherification and oxidation. Though these reactions, the degree of hydrogen bonding can be decreased, resulting in enhanced solubility in organic solvents and a variety of useful polymers can be created. Among these modified forms of cellulose, cellulose acetate is by far the most important material, because of its broad range of applications in fibers and plastics. In general, cellulose diacetate(CDA) is used as a fiber or film and is processed in solution using acetone as a solvent, which causes extra expense to be incurred, so that it should be recycled in an additional process for economic purposes. If this solution process could be replaced with a cheap thermoplastic melt process, CDA would be a strong candidate to substitute for the commodity polymers produced by the petrochemical industry. However, the main drawback of cellulose diacetate is that its melt processing temperature is very close to its decomposition temperature, which means that it needs to be plasticized in order to be used in thermoplastic processing applications.