(56)

Fabrication of Nanofibrillated Cellulose (NFC) Based Composite Materials for Engineering Applications

Kahawita K.D.H.N.[1], Samarasekara A.M.P.B.[1*], Amarasinghe D.A.S.[1], Karunanayake L.[2]

[1]Department of Materials Science and Engineering, University of Moratuwa, Sri Lanka
[2]Department *of Chemistry, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*
**banduamp@gmail.com*

Abstract

Nanomaterials play an important role as modern engineering materials for various engineering, medical and biological applications today. Nanocellulose is a natural polymeric fiber that has a minimum of one dimension within the nanometer scale and exhibits a potential as a reinforcement agent for various materials. Nanocellulose can be extracted from plant materials such as agricultural, agro-industrial and forestry wastes. They are divided into two main classes as nanofibrillated cellulose (NFC) and nanocrystalline cellulose (NCC). Compared to NCC, NFC has gained a considerable attention because of the interesting properties including high mechanical properties, reinforcing ability and aspect ratio. Combination of NFC with synthetic polymer materials is an interesting area in the polymer-based researches to enhance mechanical and thermal properties of the composite. These natural plant based composites deplete the environmental pollution created by traditional synthetic polymers. Polypropylene is a widely used thermoplastic material in engineering composite applications as a matrix material. The objective of this research was to fabricate a polypropylene and NFC based composite material. In nature, NFC is hydrophilic and polypropylene is hydrophobic. Therefore, modification of NFC surface is necessary to prepare a nanocomposite with a better performance. In the present research analyzed the mechanical, thermal, water absorption and processability properties of polypropylene-NFC-based composite with up to 5 wt.% loading of unmodified silane (Si-69) and silane (Si-69) surface modified NFC reinforced composites. The characterization of raw materials and the composites were performed using SEM, FTIR, XRD, TGA and DTA techniques. In addition, the mechanical properties of composites were evaluated by using a universal testing machine and hardness tester. Further, the melt flow rate and water absorption properties of the developed products were evaluated using standard test methods. The best thermal resistance and mechanical properties were given by the 3.5 wt.% of silane surface modified NFC loaded polypropylene composite including tensile strength (28 MPa), hardness (78 Shore D) and impact strength (4 kJ m^{-2}) and these values are 7%, 13%, and 86% higher than that of the pure polypropylene respectively. In addition, the composite sample has the intermediate level of water absorption (0.1 wt. %) and processability (21.1 g/10 min) with respect to all the other fabricated samples including pure polypropylene. The prepared nanocomposite material can be used for many engineering applications such as packaging, constructions, automotive and aerospace as a sustainable material.

Keywords: Nanofibrillated cellulose, Polypropylene, Surface modification, Nanocomposite