Available online at www.sciencedirect.com

ScienceDirect

Procedia Chemistry 19 (2016) 253 – 258

Procedia Chemistry

5th International Conference on Recent Advances in Materials, Minerals and Environment (RAMM) & 2nd International Postgraduate Conference on Materials, Mineral and Polymer (MAMIP), 4-6 August 2015

Effect of Kenaf Fiber as a Reinforcement on the Tensile, Flexural Strength and Impact Toughness Properties of Recycled Polypropylene/Halloysite Composites

Neng Sri Suharty[a]*, Hanafi Ismail[b], Kuncoro Diharjo[c], Desi Suci Handayani[a], and Maulidan Firdaus[a]

a Chemistry Department, Faculty of Mathematics and Natural Sciences, Sebelas Maret University, Jl. Ir Sutami 36A Surakarta, Indonesia
b School of Materials and Mineral Resources Engineering, Engineering Campus, Universityy Sains Malaysia, 14300 Nibong Tebal, Pulau Pinang, Malaysia
c Department of Mechanical Engineering, Faculty of Engineering, Sebelas Maret University, Surakarta, Indonesia

Abstract

Composites rPP/DVB/PP-g-AA/Hall and rPP/DVB/PP-g-AA/KF/Hall have been reactively synthesized in xylene solution. The starting materials are recycled polypropylene (rPP), divinylbenzene (DVB), and PP-g-AA coupling agent, halloysite (Hall) and kenaf fiber (KF). By using ASTM D638, D6272 and D6110, the mechanical properties of composites which are measured: tensile strength (TS), flexural strength (FS) and impact toughness (IT), respectively. The result of the rPP/DVB/PP-g-AA/Hall (C1) composite test shows that the TS increased up to 52%, the FS to 10% and the IT to 7% compared to that of starting material rPP. In the mean time, the addition of 20% (w/w) of KF as a second reinforcement to form rPP/DVB/PP-g-AA/KF/Hall composites (C3) is able to increase the TS by 18%, the FS by 28% and the IT by 27% compared to the composite without KF (C1).

Peer-review under responsibility of School of Materials and Mineral Resources Engineering, Universiti Sains Malaysia

*Keywords:*recycled polypropylene ; halloysite ; kenaf fiber ; composites

1. Introduction

Composite is a very interesting compound because it is not found in nature directly, but it is result of engineering. Composite is a mixture of different material nature to produce new materials with new properties as required.

Peer-review under responsibility of School of Materials and Mineral Resources Engineering, Universiti Sains Malaysia
doi:10.1016/j.proche.2016.03.102

Manufacture of high mechanical properties composite can be done by adding of a clay or fiber as reinforcement in polymer matrix. Had been reported that the addition of kaolin as reinforcement in PP/EPDM to improve the mechanical properties and also reduce the cost of manufacture[1, 2]. Both composites of montmorillonite (MMT) with polylactide (PLA) [3] either organic modified MMT with aliphatic polyester (APES) [4] can improve the mechanical properties and degraded. Composites polyamide 6 contain halloysite can increase the young's modulus up to 90%[5]. The previous work, had been reported that rPP/DVB/PP-g-AA/Bentonite/ZB composite by using recycle polypropylene (rPP), PP-g-AA coupling agent and bentonite as reinforcement capable to improve the mechanical properties and decreased burning rate of the composite[6]. In one hand, the addition of clay in polymer matrix will increase its mechanical properties, on the other hand, although it is strong, it has no elasticity and tend to be brittle. Therefore, it is necessary to add a second reinforcement material such as, natural fiber to improve its nature.

One of the well-known natural fibers that has ability as a reinforcement is kenaf fiber (KF), which has a high cellulose content thus has high tensile strength, ductile and not brittle[7]. A few researchers[8, 9] reported that the use of KF in the PP matrix can improve the mechanical strength of composites. Composites polybutylene succinate (PBS) combine with rice husk ash or sawdust can improve the mechanical properties also biodegradable[10]. Manufacture polyethylene composites by added with KF also can improve the mechanical properties[11]. It has been reported that the synthesis of rPP/DVB/AA/bamboo fiber composite can improve the mechanical properties and its biodegradability[12].

In this study, it will synthesize: (1) rPP/DVB/PP-g-AA/Hall composite by using the rPP as a matrix, the divinylbenzene (DVB) as a crosslinker and PP-g-AA as a coupling agent and the halloysite as a first reinforcement, (2) rPP/DVB/PP-g-AA/KF/Hall composite containing KF as a second reinforcements. The objective of this research is to study the effect of adding KF as a second reinforcement against mechanical properties and morphology difference of fracture cross-section after the tensile strength test.

2. Experimental

2.1 Material Preparation

All chemicals as starting compounds are in pro-analysis grade except mentioned, and used as such without further purification. Recycled PP (rPP) used in this work is the cup waste of mineral water packaging. The rPP samples after cleaned up, washed with ethanol and dried, then chopped in 2 x 2 mm. The KF was supplied from the centre of manufacturing wood fiber kenaf in Lamongan Indonesia. The KF after cutting in 5 mm size, then delignification by soaking in NaOH 4% for 24 hours, and then washing with water and dried. The halloysite was supplied by Applied Minerals Inc., USA. The halloysite powder after sieving in 200 mesh and then was done calcinated at 800 ^{O}C in a furnace for 1 hour and allowed to stand for 24 hours. Their composition consists of (wt %): SiO_2, 51.88; Al_2O_3, 41.26; Fe_2O_3, 2.38; CaO, 0.58; MgO, 1.04; K_2O, 0.14.

2.2 Processing of Composites

The formulation of rPP (C0) rPP/DVB/PP-g-AA/Hall (C1), rPP/DVB/PP-g-AA/KF (C2) and rPP/DVB/PP-g-AA/KF/Hall (C3) composites synthesis are given in Table 1. Composite synthesis is reactively done by solution process using the solvent xylene equipped with a condenser, mechanical stirrer and nitrogen gas. All starting materials: rPP, DVB, PP-g-AA, Hall and KF solved in boiled xylene and mixed perfectly for 1 hour. The mixture product was evaporated to release the xylene to form masterbatches composite. Then, it was hot pressed for 20 minutes at 180 ^{O}C to produce the specimen for mechanical test[6,13].