



Effect of organoclay and preparation methods on the mechanical/thermal properties of microcellular injection molded polyamide 6-clay nanocomposites[☆]

Shyh-shin Hwang^{a,*}, Sung-po Liu^a, Peming P. Hsu^b, Jui-ming Yeh^c, Jui-pin Yang^a,
Kung-chin Chang^d, Song-nang Chu^a

^a Department of Mechanical Engineering, Ching-Yun University, Chung-Li, 32097, Taiwan, ROC

^b Department of Computer Application Engineering, Far-East University, Tainan, 74420, Taiwan, ROC

^c Department of Chemistry, Chung-Yuan Christian University, Chung-Li, 32023, Taiwan, ROC

^d Taiwan Textile Research Institute, Tucheng, 23674, Taiwan, ROC

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ABSTRACT

Polyamide 6 (PA6)/MMT nanocomposites prepared by in-situ polymerization and melt compounding methods were used in this study. The organoclay PA6 nanocomposites were then injection molded by conventional and microcellular methods. Carbon dioxide was used as the blowing agent. The effect of injection screw speed, organoclay content, and preparation methods on the mechanical/thermal properties was investigated. The results showed that the screw speed of the injection had major effect on the mechanical properties of the nanocomposites: the higher the screw speed, the greater the tensile strength. The nanocomposites have maximum tensile strength, wear resistance, and cell density at clay loadings of 3 wt.% and 5 wt.% for in-situ polymerization and melt compounding respectively. The addition of MMT also improved the thermal stability of the PA6/clay nanocomposites. The XRD results showed that the nanocomposites had no diffraction peaks when made by melt compounding.

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1. Introduction

The polyamides (PAs) were the first engineering thermoplastics produced and are the largest family in production and in practical applications. However, over the last few decades, polymer clay nanocomposites (PCNs) have become a promising and challenging area of research all over the world. Due to the high aspect ratio and large surface area of the layered clay, remarkable enhancement in material properties has been reported for the PCNs, which cannot be found in conventional composites such as polymer and glass fiber composites. The layered clay can improve tensile strength [1], boost thermal stability [2], reduce gas permeability [3], enhance corrosion resistance [4], flame retardant [5], and reduce shrinkage [6]. Moreover, the content of the clay is slightly lower in PCNs than in conventional composites.

In 1987, a research group at Toyota [7] discovered how to manufacture PA6/clay nanocomposites by in-situ polymerization. This discovery began the commercial applications of PCNs. Wu et al. [8] studied the properties of PA6/MMT nanocomposites by melt compounding. They found that the mechanical strength increased as the clay loading increased up to 4.3 wt.%, while the structure was

intercalated nanocomposites. They also found that a higher molecular weight for the PA6/MMT nanocomposites yields higher tensile strength and heat distortion temperature than lower molecular weight at the same clay loading. Bellemare et al. [9] studied the fatigue crack initiation and propagation phenomenon in PA6/MMT nanocomposites. Their results showed that PA6 nanocomposites had better resistance to crack initiation but worse resistance to crack propagation than their neat PA6 counterparts.

PCN is also applied during the foaming process where the clay serves as the nucleation agent, leading to a small cell size [10] that is useful in acoustic and thermal insulator applications [11]. Microcellular foaming blends polymer and supercritical fluid, creating millions of microcells whose size is less than 100 μm [12], improving the part's dimensional stability [13]. Yuan et al. [14] studied the crystallization and thermal behavior of microcellular injection molded PA6 nanocomposites. They have found that microcellular neat resin parts and nanocomposites parts were found to have lower crystallinity in the core and higher crystallinity in the skin, compared to those manufactured by solid molding.

There has been little research exploring the mechanical properties of microcellular injection molded PCNs by in-situ polymerization and melt compounding. In this paper, we look at microcellular injection molding, a commercially useful process, studying the effects of injection screw speed, the organoclay, and the preparation methods of the PCN, on the mechanical properties, shrinkage, and thermal stability of microcellular injection molded PA6/MMT nanocomposites.

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* Corresponding author.

E-mail address: stanhwang@cyu.edu.tw (S. Hwang).