



# Preparation, damping and thermal properties of potassium titanate whiskers filled castor oil-based polyurethane/epoxy interpenetrating polymer network composites

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## ABSTRACT

A series of potassium titanate whiskers (PTW) filled castor oil-based polyurethane (PU)/epoxy resin (EP) interpenetrating polymer network (IPN) composites were prepared. The damping properties, thermal stability as well as tensile strength of the IPN composites were studied systematically in terms of composition. Results revealed that the addition of PTW can significantly improve the damping properties of pure PU/EP IPN and can improve the thermal decomposition temperature. Tensile tests showed that the tensile strength of the IPN composites was improved after the incorporation of PTW. It is expected that the PTW filled IPN composites may be used as structural damping materials.

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## 1. Introduction

Material damping is one of the most effective solutions to the problem of vibration and noise. Polymer composites as damping materials have attracted much attention for their high damping properties around the glass transition temperature [1,2].

Epoxy resins (EP) have been employed in high performance composites for their high modulus and strength. However, such resins suffer from the brittle behavior [3]. Polyurethane (PU) is an elastic polymer used as elastomers and composites. Nevertheless, the applications of PU are limited for its low mechanical strength and poor thermal stability [4]. PU/EP interpenetrating polymer networks (IPNs) which integrate their advantages have been studied by many researchers could solve these problems [5–9]. Studies showed that the PU/EP IPNs conquered the disadvantages of polyurethane and epoxy resins, respectively. The IPNs had a relatively high mechanical strength, damping properties and good thermal stability. However, the pure PU/EP IPNs have some faults. For example, the mechanical and thermal properties are relatively low for the character of polymer materials. And the damping properties of PU/EP IPN are low because internal friction only exists between polymer chains. To conquer these problems, atten-

tions have been paid to the modification of the IPNs. Most of modifiers are inorganic particles or fibers. Zhu et al. [10] investigated the influences of hydrogen-bonding of layered montmorillonite filled PU/EP IPN nanocomposites, and found that the stronger the hydrogen-bonding interaction, the smaller the free volume hole size, and the better the miscibility. Rama and Rai [11] prepared fly ash-filled hydroxyl-terminated polyurethane toughened epoxy composites, and results showed that addition of fly ash to an epoxy elastomer matrix significantly increases the toughness of the HTPU-modified epoxy. Lei et al. [12] reinforced the interpenetrating polymer networks of polyurethane and epoxy resin with an organophilic palygorskite, and the PU/EP IPN nanocomposites were superior to those of the pure PU/EP IPN. In our previous study [13], damping properties and tensile strength were improved by incorporated short carbon fibers and hollow glass bead into the polyether-based PU/EP IPN composites.

Potassium titanate whisker (PTW,  $K_2Ti_6O_{13}$ ) which has outstanding mechanical performance, low hardness (Mohs hardness 4), and excellent chemical stability is a kind of very fine micro-reinforcing material. The whiskers which have high specific surface area will have more interface area with the polymer matrix compared to traditional fibers. The internal friction increases with the increasing interface area. Therefore, the damping properties of the composites could be potentially increased obviously by filling potassium titanate whiskers. However, most of the studies about PTW focused on the mechanical and thermal properties [14,15]. As far as we know, there no literature about the damping properties of PTW reinforced PU/EP IPN composites.

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