The effect of γ-APS-g-MMT and Zeolite on Thermal Stabilization and Mechanical Properties of PVC in PVC/MMT nano-composite

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Thermal stability of PVC has been improved by the organic modified montmorillonite (OMMT) due to its high temperature resistance and good distribution and dispersion in PVC. It was found that organic grafted MMT (γ-APS-g-MMT) could improve thermal stability of PVC better than OMMT. The mechanical properties of γ-APS-g-MMT/PVC and OMMT/PVC of the blends were also enhanced. As zeolite was found to be an excellent HCl and heat absorption inorganic natural fillers, therefore part of the work was aimed to study thermal and mechanical properties of both PVC added zeolite and PVC containing both γ-APS-g-MMT and zeolite. The content of the fillers, i.e. γ-APS-g-MMT and zeolite were varied at 0, 3, 5, 7 and 10 phr. It was found from Thermo-Gravimetric Analysis (TGA) that the onset temperature, T_{onset}, and inflection temperature ($T_{inflection}$) of PVC increased with the content of zeolite and γ-APS-g-MMT in PVC. However, both T_{onset} and $T_{inflection}$ were level off at the γ-APS-g-MMT content of 5 phr whereas the zeolite content of 7 phr. Young's modulus of the composite also increased with the content of the fillers up to 7 phr in both cases. As expected, the modulus in PVC reinforced with zeolite was slightly higher than γ-APS-g-MMT. In the case of tensile strength, γ-APS-g-MMT reinforcing gave better enhancement for PVC than zeolite. This was due to the nano-size particle of the former filler resulting in better distribution and dispersion. However, the present of both filler still obstructed the elongation of the PVC molecule as seen from a decreased in elongation at break of the PVC composites. With the optimum thermal stabilization and mechanical properties, PVC filled with both zeolite and γ-APS-g-MMT with the content of 7 phr, in both filler types, were then studied. It was found that T_{onset} was maintained at the same temperature as PVC containing γ-APS-g-MMT alone meanwhile $T_{inflection}$ was maintained at the same value as PVC containing zeolite alone. However, all tensile properties were improved.

Keywords: Thermal stabilization, γ-APS-g-MMT, Zeolite, PVC, Thermal properties, Mechanical Proterties

1. INTRODUCTION

It is widely known that Poly(vinyl chloride) (PVC) are one of the most common plastic having been used widely owing to its good resistance to chemical and corrosion including their processability to both flexible and rigid finished products. The major problem on processing of PVC is thermal degradation. Thongpin and co-worker [1] reported that the presence of PE could prolong thermal stability of PVC during processing in extrusion via radical transfer mechanism. Thermal stabilizers are commonly used in PVC compounds. Their operation involves a reaction with HCl produced by thermal experienced during the plastic processing. The commercial stabilizers used for PVC includes metal soaps (lead, calcium, zinc, barium, aluminum and their composites), organotin compounds, organic stabilizers and inorganic stabilizers (zeolite and hydrotalcite). Metal soaps are used to displace the labile chlorine atom in PVC polymer chains by the ester from the decomposed stabilizer to stabilize the PVC. In addition, they can trap HCl gases to retard the damaging autocatalytic action of HCl released by PVC chains [2-6]. Inorganic fillers such as zeolite and clay can also act as thermal stabilizer. It was reported by Atkul [3] that zeolite can stabilize PVC by acting as acid absorber.

A number of researches [7-9] were concentrated on PVC/MMT nano-composite for their benefits on mechanical, thermal and optical properties of PVC/MMT composites. Jianxin Du [7] studied the PVC/organic modified MMT nano-composite system and found that PVC in PVC/OMMT composite exhibited higher rapidest degradation temperature. Chaoying Wan et al [8] studied the effect of organic modifiers, which were trimethyloctadecyl ammonium (MMT-C_{18}) and dimethyldioctadecyl ammonium (MMT-2C_{18}), on the morphology of MMT in PVC/OMMT composites. It was clear that partially intercalated and exfoliated structure of MMT coexisted the PVC matrix subsequently enhance the mechanical properties and optical property of the composite. Later, Chaoying Wan et al [9] studied PVC/MMT and PVC/OMMT composites, in which organic part in the OMMT derived from alkyl quaternary ammonium. They reported that the organic modifier accelerated the discoloration of the PVC in PVC/OMMT composites, owing to the strong acidic sites left on the molecule of alkyl quaternary ammonium after its decomposition. The active sites could catalyze the dehydrochlorination and discoloration of PVC. Nonetheless, the result from this research showed that the thermal and mechanical properties of PVC/OMMT composites were better than unfilled PVC.

Fangling Gong and coworkers [10] studied PVC/MMT nanocomposites. The MMT added in the composites was organically modified with dimethyl didiodecyl ammonium chloride (DDAC) by intercalate polymerization. It was revealed that the thermal stability of composite increased with the content of OMMT, whereas onset of PVC in the PVC/OMMT composite decreased with the present of OMMT. Peprnicek et al [11] concluded from their work that the nature and the treatment of the filler and processing