Thermal Stability, Flame Retardancy and Mechanical Properties of Polyamide/Montmorillonite Nanocomposites Prepared By Melt Processing

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BACKGROUND INFORMATION

The increase in thermal stability, flame retardancy, and mechanical properties of Polyamide 6 (PA6)/montmorillonite (MMT) nanocomposites open a new research window in respect to successful technical application of PA6/MMT nanocomposites on the industrial scale. This illustration provides important indication to understand a widely reported but poorly identified phenomena of catalysing effect of different ions, materials, or compounds present in MMT during the combustion of PA6/MMT nanocomposites.

PROJECT AIM & OBJECTIVES

AIM: To develop and improve flammability of PA6/MMT nanocomposites

OBJECTIVES:

- To evaluate the best available technique to modify MMT with surfactant (e.g. organic modifier)
- To select the sustainable and viable technique to produce PA6/MMT nanocomposites (e.g. melt process using single/twin screw extruder and injection moulding
- To identify the exact degradation/decomposition mechanisms of PA6/MMT nanocomposites.
- To evaluate the catalytic behaviour of different flame retardant additives present in MMT such as, some mineral compounds, halogenated compounds, phosphorus-based flame retardants, nitrogen-based flame retardants, silicon-based flame retardants, and nanometric particles.

PROJECT WORKPLAN

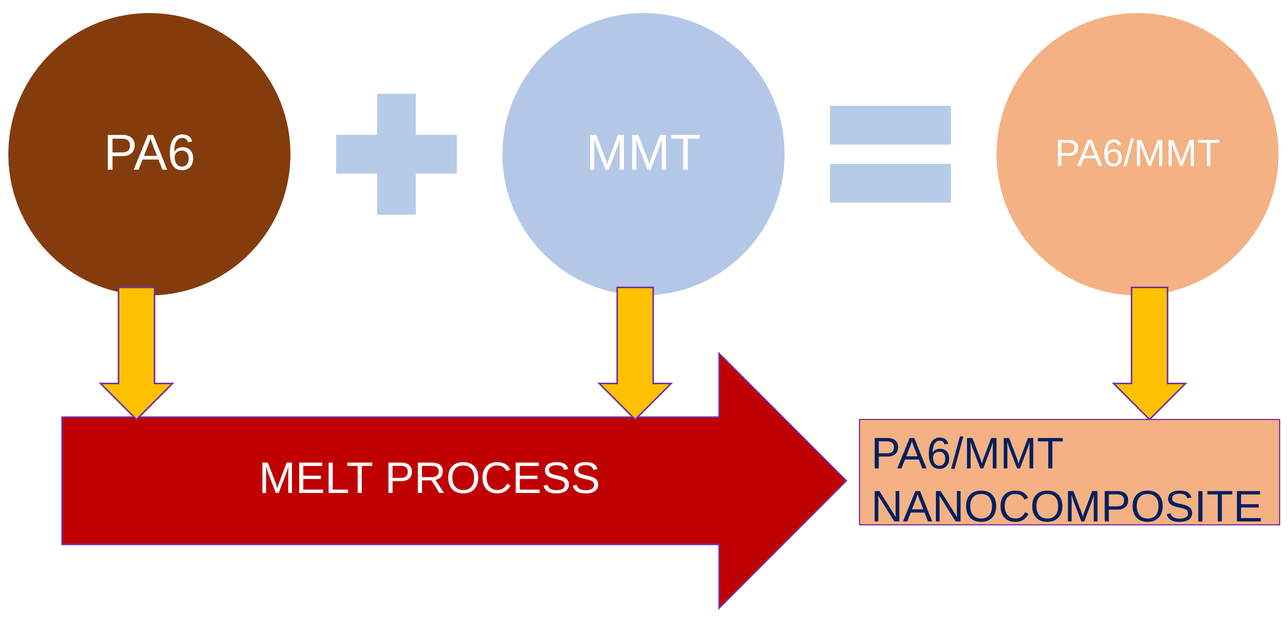

Figure 1: Nanocomposite fabrication process via extrusion

MECHANICAL & FLAME/FIRE TEST

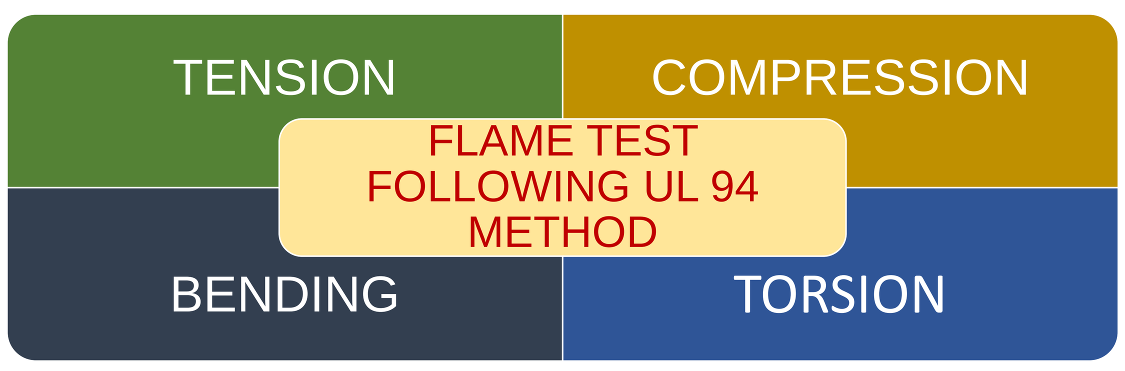

Figure 2: Mechanical and thermal (flame/fire) property analysis

REFERENCES

Leszczyńska A Njuguna J Pielichowski K Banerjee J R 2007 *Polymer/montmorillonite nanocomposites with improved thermal properties: Part I. Factors influencing thermal stability and mechanisms of thermal stability improvement.* Thermochimica Acta, Volume 453, Issue 2, Pages 75-96

Zope IS, Dasari A, Guan F, Yu Z, 2016. *Influence of metal ions on thermo-oxidative stability and combustion response of polyamide 6/clay nanocomposites*. Polymer 2016;92:102-113

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PHASES, MECHANISMS, AND REACTION PROCESSES

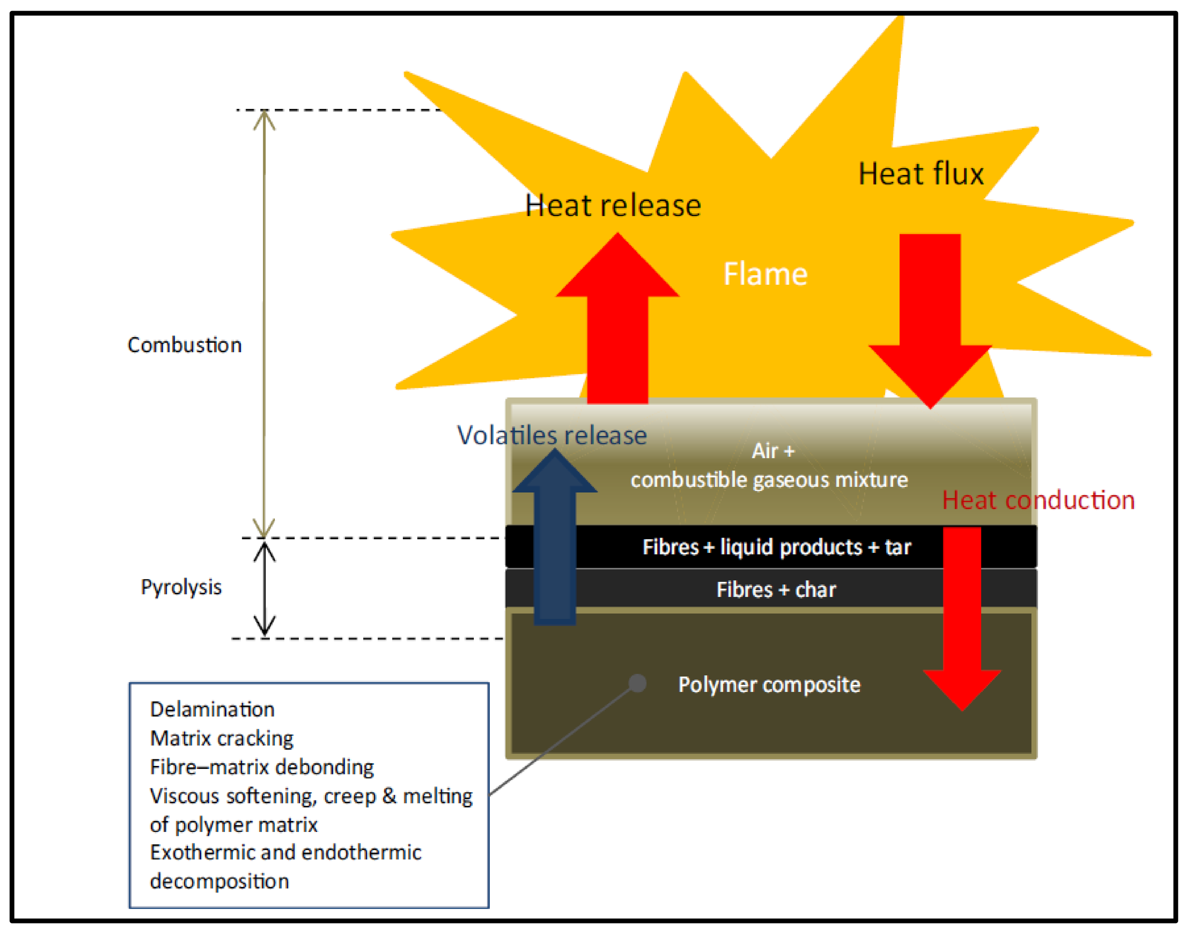

Figure 3: Schematic diagram of the different phases, mechanisms, and reaction processes involved during the exposure to fire of a polymer nanocomposite.

MONTMORILLONITE & ITS MODIFICATION

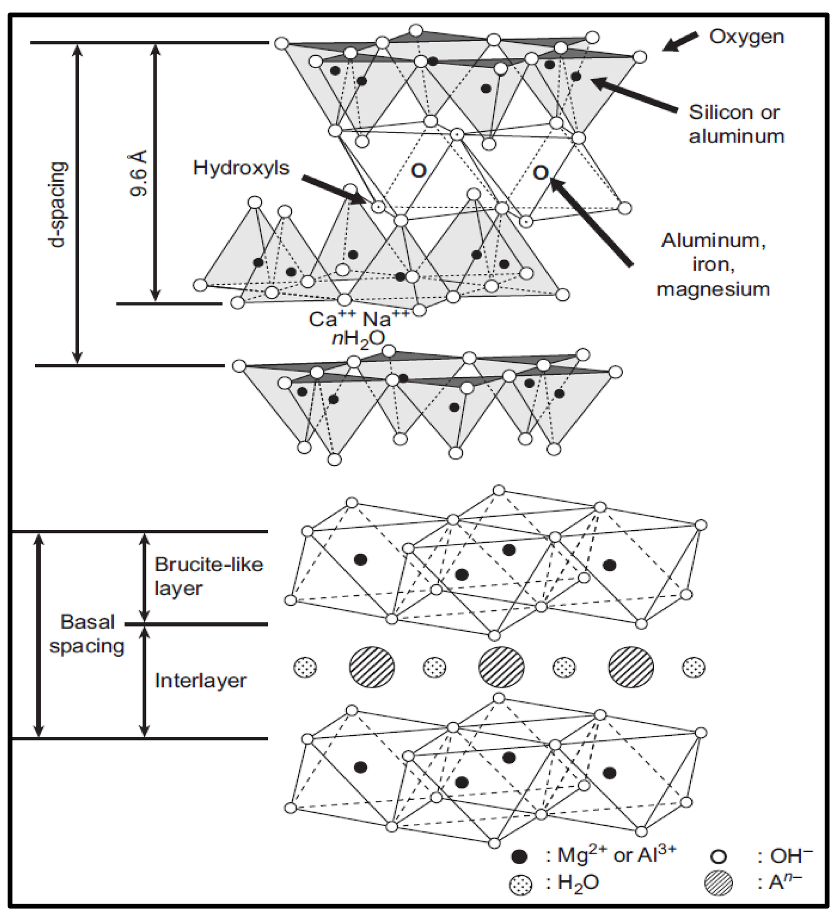

Figure 4: Schematic illustration of MMT

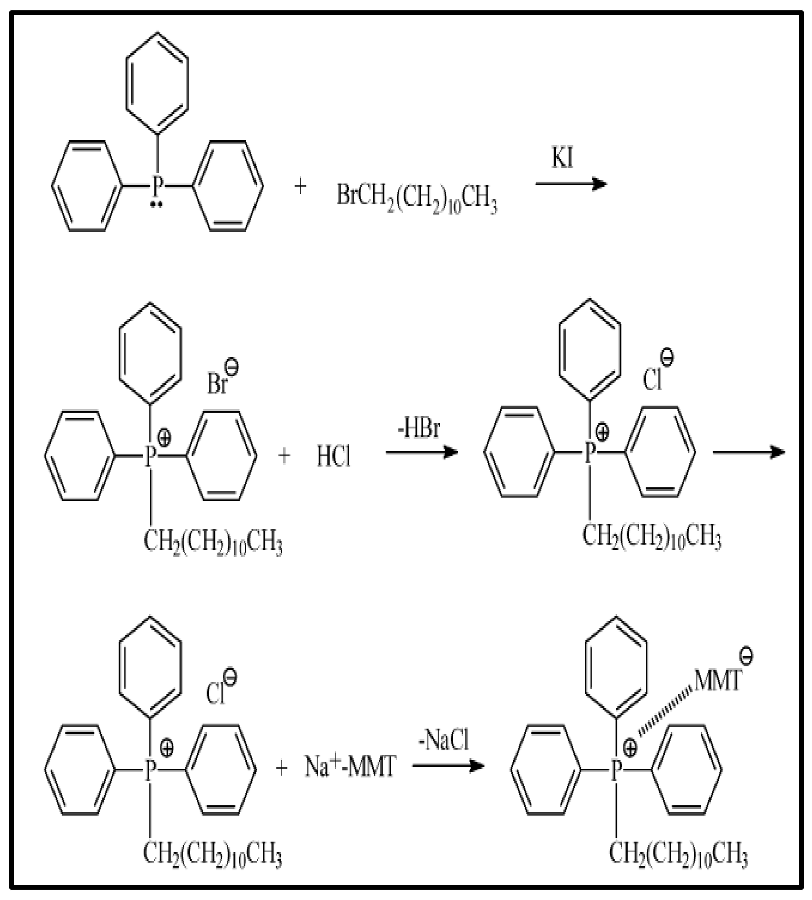

Figure 5: Synthesis of an organically modified MMT

EXPECTED RESULTS

It is believed that the thermal stability of PA6/MMT nanocomposites largely depends on the amount of organoclay present in MMT and the dispersion process. It is still not clear/evident that how does this dispersion process can be intensified or how does the metal (e.g. Mg^{2+} , Al^{3+} , Fe^{3+}) ions influence the thermal properties of PA6/MMT nanocomposites. It is expected that certain metal analysis before and after (leachate test from PA6/MMT nanocomposite) the melt process may indicate the mechanisms behind the flammability properties of that nanocomposite. However, it is also expected that the improvement of flame retardancy property does not deteriorate the mechanical properties by performing tension, compression, bending, and torsion test.