

# Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) of Wood polymer nanocomposites

Md. Rezaur Rahman<sup>1,a</sup>, Sinin Hamdan<sup>2</sup>, Josephine Lai Chang Hui<sup>1</sup>

<sup>1</sup>*Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia*

<sup>2</sup>*Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia*

**Abstract.** This study evaluates the thermal property of clay dispersed Styrene-co-Glycidyl Methacrylate impregnated wood polymer nanocomposite (WPNC). The WPNC was characterized by FTIR, TGA and DSC methods. FT-IR result showed that the absorbance of wave number at 1730 cm<sup>-1</sup>, increased for clay dispersed Styrene-co-Glycidyl Methacrylate wood polymer nanocomposite (ST-co-GMA-clay-WPNC). From TGA, ST-co-GMA-clay-WPNC showed better thermal stability at the temperature below 450oC. The final weights of ST-co-GMA-clay-WPNC and ST-Clay-WPNC, between 420 and 700oC, were significantly less than the raw wood. When the temperature was below 450oC, nanoclay-incorporated surface modified wood composites showed enhanced higher thermal properties compared with those without nanoclay. From DSC, the degradation enthalpy at around 360oC of ST-co-GMA-Clay-WPNC was the highest.

## 1 INTRODUCTION

Wood is one of the most widely used construction materials due to being unique renewable, having good physical and mechanical properties, aesthetic appearance, environmental and health aspects [1-3]. Wood has increased attention by the material researcher for replacing synthetic plastic materials which is not renewable and eco-friendly [4-6].

The constituents of wood are basically a series of tubular fibers or cells cemented together. Cellulose is highly responsible for wood strength for its linear orientation and a high degree of polymerization in wood. Hemicelluloses act as a coupling agent to bind noncrystalline hydrophilic cellulose and amorphous hydrophobic lignin. Cellulose, hemicellulose, and lignin are mainly responsible for mechanical properties of wood. The macromolecule of cellulose is formed by covalent bond which is resistance for tensile stress and hydrogen bonds within the cellulose provide rigidity by transferring stress. At high humidity, wood is dimensionally unstable and susceptible to termites' attack for taking water from the environment in its cell walls and cavities due to its hydrophilic and capillarity properties [7]. At low humidity environment, wood desorbs water to shrinkage. Hygroscopic and dimensionally unstable properties restrict the use of wood. In outdoor applications, wood suffers from the photodegradation process [8]. Wood also disclosures when uses indoor by oxidation of lignin, albeit with lower intensity [9]. However, the carbon based cellulosic material, wood is thermally unstable when it is subjected to heat in suitable conditions [10]. To overcome the above drawback, modified wood such as wood plastic composites, and wood composites are used as wood materials instead of conventional wood [11, 3]. For decreasing hydrophilicity and fungal attack of wood, various chemical treatments have been introduced such as acetylation, benzylation, silane or maleic anhydride

grafting, etc. In all these chemicals react with -OH groups of wood [12].

When wood is subjected to heat flow, there produces pyrolysis products which can also reduce or increase heat production. The mechanism of thermal stability property of wood composite depends on its fire-retardant chemicals and chemical modification of wood cell wall [13]. Fire retardant chemicals in pyrolysis reactions increase the formation of char and water, and therefore reduce the effective heat of combustion and the yield of the flammable gases [14-15]. Phosphoric acid is one of the most uses fire retardant chemicals to reduce the number of volatiles and to increase the amount of residual char [16, 17]. Al (OH)<sub>3</sub> and Mg (OH)<sub>2</sub> are used as heat retardant materials for their endothermic property and their dehydration property dilute the combustible fuels and oxygen [18]. Silicates as heat retardants in wood composite make silica carbon compound which creates a barrier, but this residue is structurally very weak [19, 20]. Montmorillonite clays, TiO<sub>2</sub>, Sb<sub>2</sub>O<sub>3</sub>, aluminosilicates, vermiculite, perlite and organoclays are used as heat retardants material to increase the thermal stability of wood [21-23]. Chemically modified and nanofiller impregnated wood gain mechanical and thermal properties [24].

For evaluating the effectiveness of thermal property of treated wood various methods have been developed such as thermal analysis, tunnel flame-spread tests, critical oxygen index tests, smoke production tests, fire tube test, cone calorimeter, heat release rate, toxicity and analysis of solid residue or gaseous products of thermal decomposition [14, 15]. Among these methods, differential scanning calorimetry and thermogravimetry are simple methods for evaluating the pyrolysis and flame retardants under air or inert gas flow.

The present study investigates differential Scanning Calorimetry (DSC) and thermogravimetric (TGA) properties of clay dispersed Styrene-co-Glycidyl

<sup>a</sup> Corresponding author: [rmrezaur@feng.unimas.my](mailto:rmrezaur@feng.unimas.my)