ABSTRACT

Efficient thermal management is one of the primary bottlenecks faced by many diverse industries, including electronic packaging, integrated circuits, microelectronics, high power electronic devices etc. With the integration of the microelectronic circuits increasing day by day, more and more heat is produced when the circuit operates. The generated heat must be dissipated away in time to prevent over-heating. This requires that the packaging materials must have high thermal conductivity to dissipate the generated heat and low coefficient of thermal expansion to match with that of silicon, besides traditional physico-mechanical properties. Polymers reinforced with thermally conductive particulate-fillers are widely used for heat dissipation application in electronic packaging of integrated circuits, because of their high thermal conductivity, low coefficient of thermal expansion and light weight. Polymer nanocomposites have attracted great attention of several researchers due to their improved properties compared to the conventional microcomposites. Owing to the several outstanding intrinsic properties of nano-sized particulate-fillers, (< 100 nm), polymer nanocomposites are expected to show unprecedented property improvements, especially, at low filler concentrations. In the present program, HDPE thermoplastic polymer-matrix reinforced with various vol.% loading (0-20vol.%) of inorganic AlN nano-particles have been prepared through melt-mixing method followed by compression moulding and hot pressing process. Detailed investigations of the reinforcement effect of inorganic AlN nanoparticles on the micro-structural, topographical, thermal stability, non-isothermal degradation kinetics as well as on the thermal degradation kinetic mechanisms of the HDPE polymer nanocomposites (PNCs) have been performed using XRD, DSC, HR-TEM, FEG-SEM, AFM and TG-DTG respectively. In addition, nano-mechanical properties using both static and dynamic depth-sensing indentation (DSI) techniques for all the prepared HDPE/nano-AlN composites have been studied in detail. Effective thermal conductivity (K_{eff}) and finite element modelling (FEM) of pure HDPE and nano-AlN particle filled HDPE polymer nano-composites have also been investigated.

Keywords: *HDPE / nano-AlN, Polymer nanocomposites, Thermoplastic polymer-matrix, Inorganic AlN nanoparticles, Melt mixing method, Micro-structural, Topographical, Thermal stability, Non-isothermal degradation kinetics, Kinetic mechanisms, Depth sensing indentation, Nano-mechanical properties, Density, Thermal conductivity, Finite element modelling.*