Research Project: Rail Car

Research Topic: Thermogravimetric Analysis (TGA)

Problem

TGA is essentially an electronic balance monitoring the weight of a sample throughout a process, which can be heating, cooling, isothermal, reaction, decomposition, and so on. The sample is tested in a controlled atmosphere.

Approach

TGA is a quantitative analysis tool measuring the properties of a material associated with heat. It is carried out by programming the temperature and plotting weight or weight percentage against temperature or time. During thermogravimetric analysis, heat can be used to induce chemical or physical or both change in materials, which may result in variation in mass that is real-time recorded. From the curve of weight against temperature (or time in some cases if needed), important information such as moisture content, thermal stability and reactivity can be found at specific temperature or over a temperature range. A TA Instruments Model Q500 TGA, Figure 1, was bought and being used at the University of Mississippi. It can run from room temperature to 1000 ^{o}C.

Figure1. TA Q 500

TGA is often used to analyze materials from organic to inorganic including polymers, composites, laminates, adhesives, food, coatings, pharmaceuticals, rubber, petroleum chemicals, explosives, metal oxides and biological samples.

Finding

TGA is currently being used to quantitatively characterize nano particles, especially to determine grafted functional groups through functionalization. It also determines the thermal stability of graphenes and the moisture content. The loading of carbon fillers in composite may be found by performing TGA analysis. It is very convenient to monitor the carbonization of polymer or composite in nitrogen (Figure 2) or the burning of polymer or composite in air under heating program. Figure 3 shows the stability of 5 micron size graphenes bought from Michigan State University. Moisture is about 1.1 wt%. The weight loss above 200 ^{o}C should come from functional groups and the amorphous carbon.

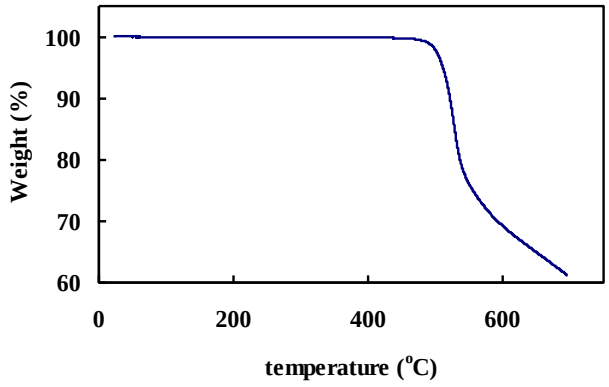

Figure 2. xGnP-PEI paper (MSU), in nitrogen, heating 10 ^{o}C/min.

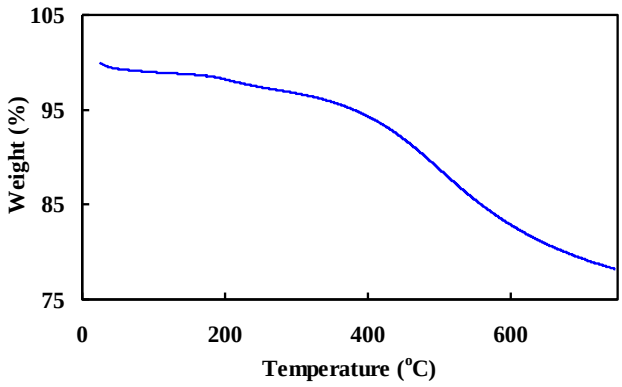

Figure 3. xGnP-M-5 (MSU), in nitrogen, heating 10 ^{o}C/min.

Impact

TGA is normally the first and inexpensive tool in characterizing nano materials to indicate whether or not the functionalization is successful and the degree of functionalization. The mass fraction of functional groups, determined by TGA, is then used to guide further chemical reaction or embedding of nano reinforcements in composite.

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