Investigation of Different Types of Biochar on the Thermal Stability and Fire Retardancy of Polymer Composites

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Fire is a very important and severe hazard that involves all flammable materials, in particular polymers. In this context, it becomes very important to provide flammable materials with flame retardant features, so that the former can withstand the application of a flame or of an irradiative heat flux, hence becoming suitable for specific applications (civil construction engineering, transportation, furniture, among a few to mention). Besides, the way employed for imparting flame retardant properties is a key issue: in fact, it is possible to incorporate the flame retardant in the bulk material, or to selectively locate it on the material surface. It is worthy to note that, being equal the content, usually the application of the FR onto the material surface has some advantages, namely: the overall mechanical behavior of the flame retarded material is not affected and it is possible to lower the FR loading required for an acceptable fire performance. The aim of this Ph.D. dissertation is to explore various flame retardant systems using bio-sourced FR. In this way it is possible to combine the 'green' character of these materials with the current need to provide wastes and by-products with further added value In view of sustainability, the use of biochar (BC), a solid product obtained from the thermo-chemical conversion of wastes/biomasses in an oxygen-limited environment, represents a renewable/bio-sourced material that has been widely utilized in environmental management and agriculture. In addition, it has been exploited as a low-cost carbon sequester and a natural adsorbent, as well as in soil remediation and amendment, thanks to its remarkably stable honeycomb-like carbonaceous structure. All these peculiarities suggest the possibility of using biochar either as a filler in polymer composites with enhanced thermal and flame retardant properties, or as a component of flame retardant coatings, hence further widening its potential uses. In this Ph.D dissertation, thermoplastic polymers have been chosen (i.e. ethylene vinyl acetate and polyethylene), and with compound technique the biochar was incorporated into the polymers as flame retardants. Using the thermo-compression and injection molding processes, the specimens were molded and used for forced combustion and flammability tests (i.e., cone calorimeter and UL-94). Furthermore, various masterbatch of biochar and polymer were prepared and then applied to the surface of unfilled matrix by thermocompression. Both the systems turned out to significantly improve the overall flame retardant features of the polymer. In this thesis, different types of BC were used from various feedstock and the properties of their respective compounds were thoroughly investigated.