SUMMARY

Functionalised biochar for fire-retardant & bio-based composites

The recent interest in renewability and sustainability has Although flame/fire retardants are very effective in reducing the fire hazard of plastics, their presence in the resin matrix may be detrimental to the mechanical strength. Hence, in order to have a holistic improvement of performance properties, a new approach has been developed wherein biochar pores are used to host fire-retardants. The issue of loss in mechanical strength of a plastic is alleviated by the use of reinforcing biochar whereas the fire-safety is enhanced by the presence of the fire retardants.

Aims

The project aimed to investigate if it is possible to create a balance between the fire and mechanical properties in plastics by adding biochar doped with sustainable fire-retardants.

Methods and implementation

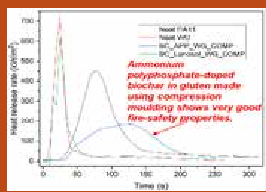
An innovative method was attempted wherein sustainable fire-retardants were doped inside the numerous pores of biochar and this functionalised biochar was then integrated within bioplastics to create novel biocomposites.

The project included experiments that were divided into two parts. In the first part, three doping mechanisms for fire-retardant i.e., lanosol were investigated on wheat gluten bioplastic followed by detailed flammability, mechanical and thermal kinetic analyses. In the second part, another fire-retardant, namely, ammonium polyphosphate was doped using the best mechanism identified previously. A different bioplastic, Nylon-11 was also used and manufacturing of biocomposites was done using both compression and injection moulding. Finally, a biocomposite having the most desirable doping method, fire-retardant, bioplastic and made using a suitable processing method was identified.

Results

The project identified that fire-retardants can be effectively doped inside the pores of biochar using a thermal method. This functionalised biochar can then be used to develop biocomposites whose fire-resistance and mechanical properties are balanced. In particular, the biocomposite can be made fire-safe without compromising its mechanical strength. The doped fire-retardants will not be in the plastic's matrix and thus, will not act as the detrimental stress concentration points to lower mechanical properties. However, their presence in the composite system will still bestow the necessary fire-safety to the biocomposite.

Amongst the two different fire-retardants, bioplastics and processing methods used, the composite having ammonium polyphosphate in gluten bioplastic made using compression moulding technique had the best fire-safety properties with acceptable mechanical strength. The composite having lanosol in gluten made by compression moulding exhibited a balance between the mechanical and fire properties. Therefore, if fire retardancy is the ultimate aim of the composite application with acceptable mechanical properties then ammonium polyphosphate doped biochar in gluten will be the best option. However, for overall acceptable properties (both mechanical and fire), lanosol-doped biochar in wheat gluten composite will be appropriate.



PROJECT TEAM

FINANCED BY

BRAND FORSK

Brandforsk's activities are made possible by support from various organisations in the community.
www.brandforsk.se