Effect of graphene nanosheets on morphology, thermal stability and flame retardancy of epoxy resin

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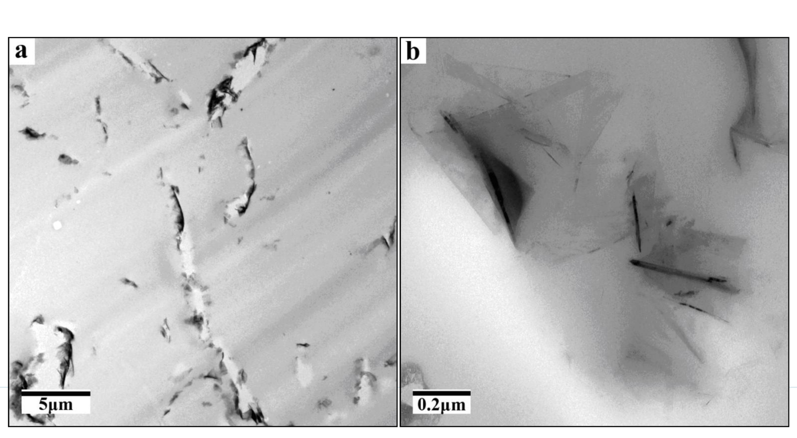
Introduction

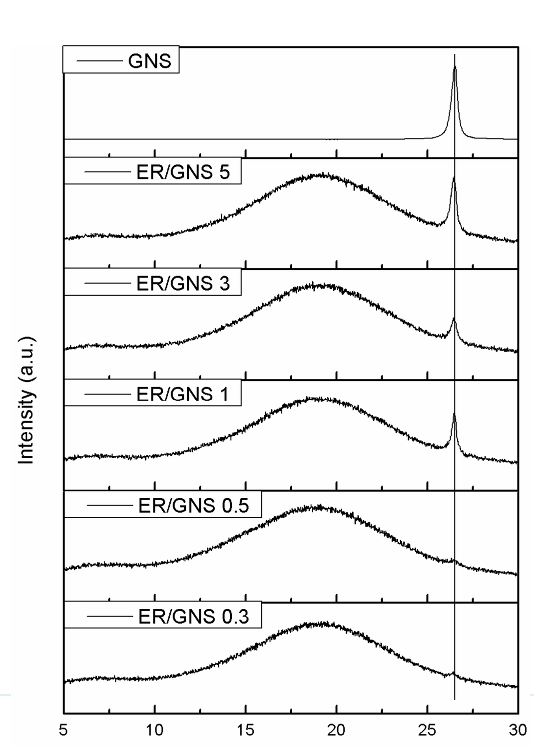
Epoxy resin (ER) is one of the most important thermoset polymers, however, flammability has restricted their applications.

Graphene nanosheet (GNS) is a new class of nano-sized filler with exceptional functions and thermal stability. It has exhibited great promise for potential applications in the fields of nano-electronics, sensors and flame retardants.

Our experiment aims to evaluate the influence of GNS on the morphology, thermal stability and flame retardancy of ER/GNS composites.

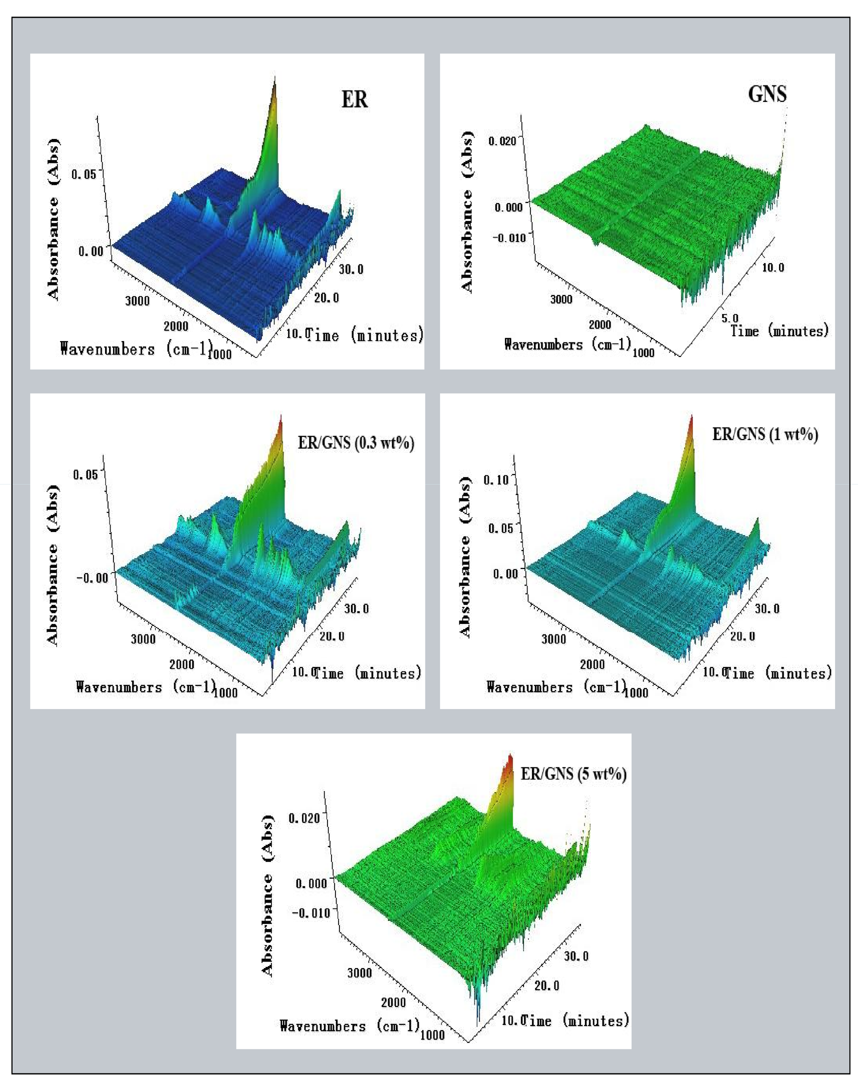
Dispersion

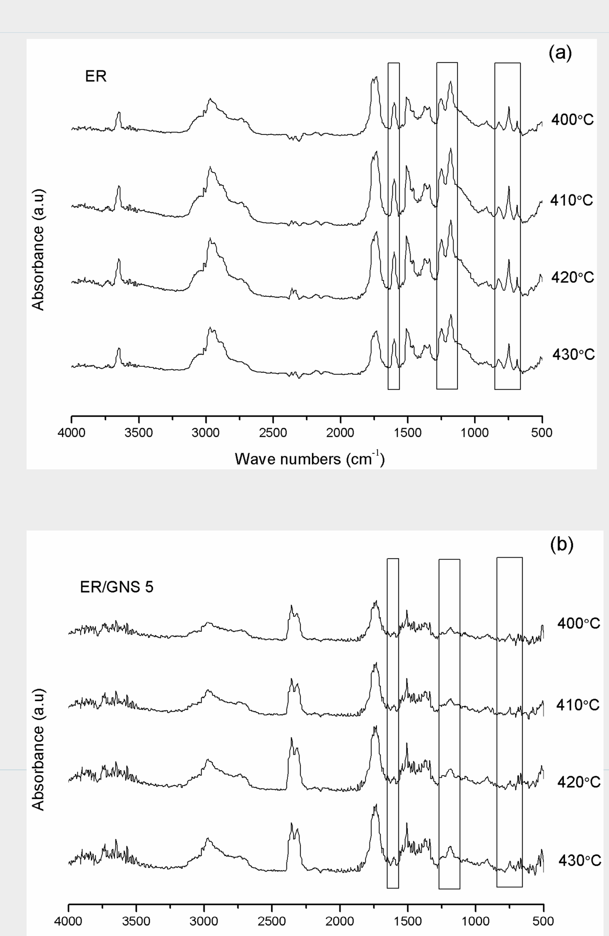




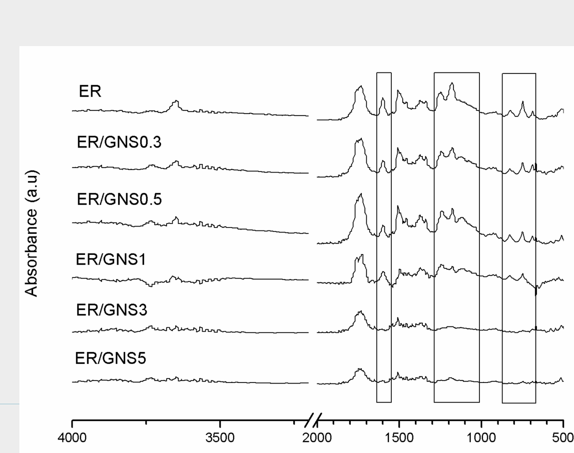
In ER/GNS, large and flat graphene flakes exfoliated, while some aggregations still exist.

Thermal degradation





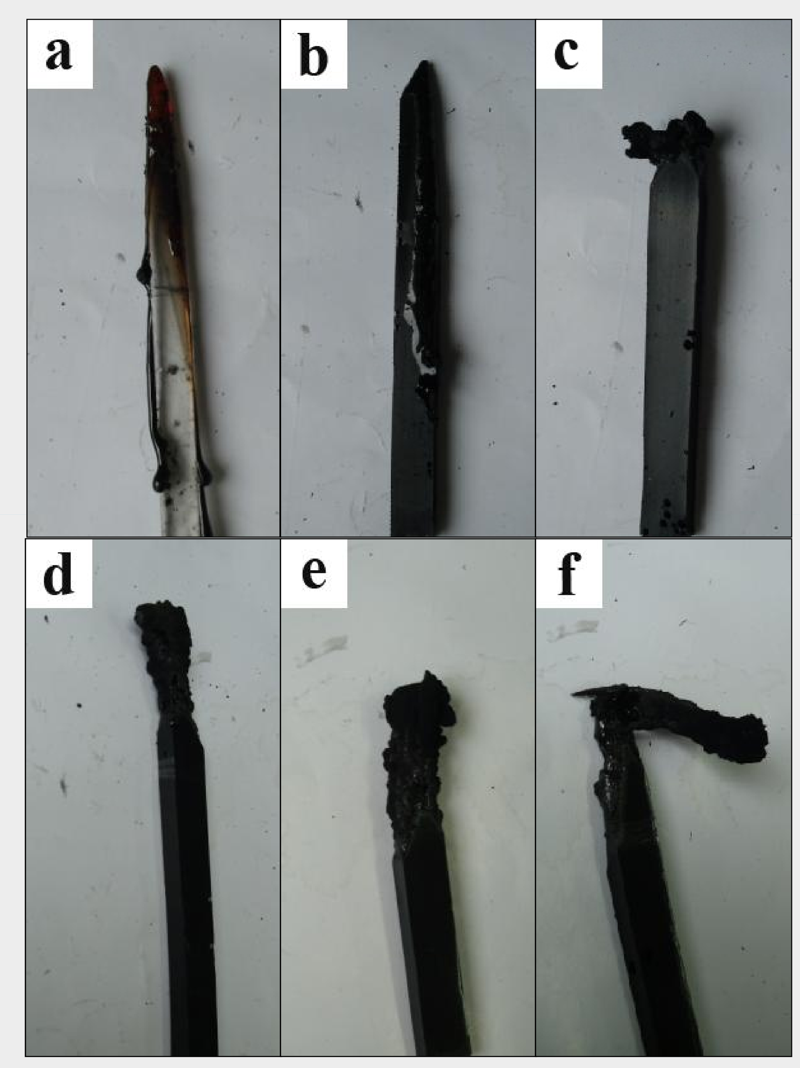
FTIR spectra of gas products at 400-430°C.



FTIR spectra of gas products at the maximum evolution rate

GNS changed the path of thermal degradation of ER within 400°C to 430°C.

Flame retardancy

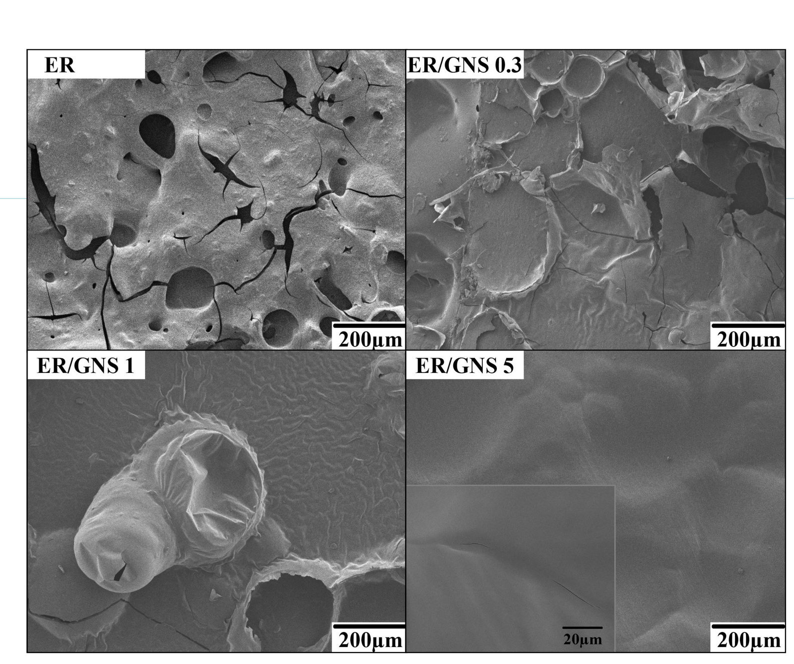


Samples after LOI tests: (a) ER, (b –f) ER/GNS 0.3, 0.5, 1, 3, 5.

GNS can decrease melt flow and drips of ER. The LOI value of ER/GNS increased with the increase of GNS content.

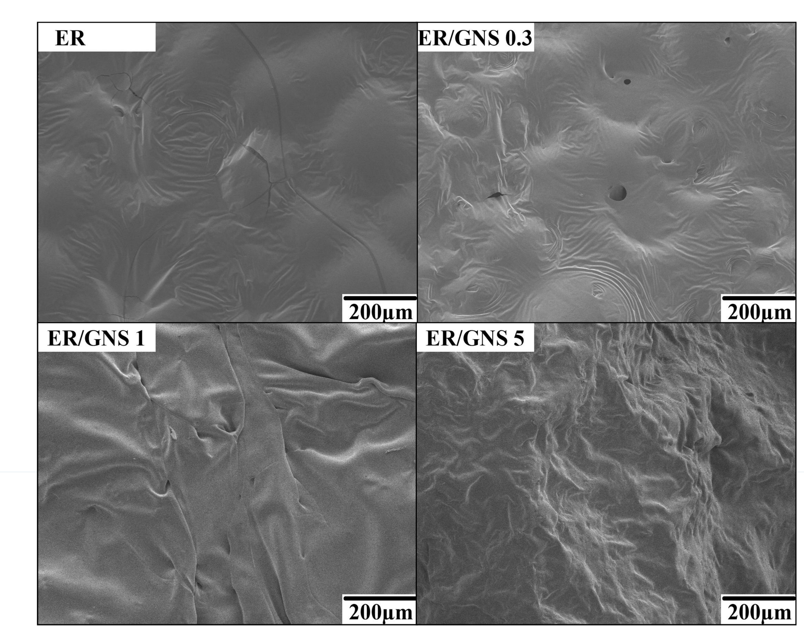
Sample	PHRR (W/g)	THR (KJ/m^2)	T_{max} (°C)	LOI
ER	424.5	33.4	393.2	15.9
ER/GNS 0.3	503.8	30.9	400.3	18.0
ER/GNS 0.5	506.1	29.7	391.3	19.1
ER/GNS 1	465.2	29.2	387.8	19.5
ER/GNS 3	446.1	28.2	385.7	21.0
ER/GNS 5	456.6	27.8	385.9	21.4

Char residue



SEM images of the bottom region of char residues

Char residue



SEM images of the surface region of char residues

ER/GNS can form more intact and continuous char than ER during combustion.

Conclusions

- GNS changed the path of thermal degradation of ER. ER/GNS can form more intact and continuous char which acts as a mass transport barrier, slowing the escape of the volatile products.
- Extended GNS-GNS and GNS-ER interactions increase the viscosity of the melt, limit flame propagation through the inhibition of dripping.

Acknowledgement

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