Highly Conductive Nanostructured Composites Based on Multi-Layer Graphene and Polymers for Flexible Heaters

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ABSTRACT

Flexible heaters, such as body heating devices for thermal comfort and improvement of poor blood circulation are increasingly necessary and desired devices. Relatively high cost of these devices nowadays prevents their high scale use. This work presents the results obtained with low cost multi-layer graphene sheets with excellent electrical and thermal conductivity produced from natural graphite and used as fillers in flexible composite materials. Flexible highly conductive films were prepared by mixing multi-layer graphene platelets with various polymers (~10% m/m) and water until formation of a viscous paste. The material was stirred continuously for 10 minutes at room temperature and then spread on a PTFE substrate film using a doctor blade technique. Samples were dried for 4 hours at 90°C and finally were calendered to provide better uniformity, alignment of graphene flakes and reduced porosity of the film material. Figure 1 shows an example of a sheet obtained (A4 size) and the micrograph image of a film cross-section.

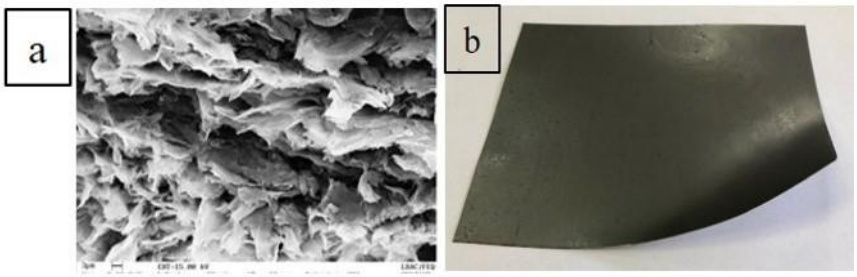

Figure 1: Multi-layer graphene based composite (A) cross-section SEM micrograph, 6000x magnification, and (B) sheet sample, 300 um thick, A4 size.

Preliminary results obtained with development of nanocomposites based on graphene nanoplatelets, show good results with the film thermal conductivity of 40,6 W/m.K and electrical resistivity of 1,2 $.10^{-2}$ Ω.cm. The results obtained for resistivity, are superior compared with those reported in literature for various polymeric composites with carbon nanomaterials: carbon nanotubes with best results in the range of 7.10^{-2} Ω.cm [1], for buckypaper of multi-walled carbon nanotubes with values close to 1.4 Ω.cm [2] and with exfoliated graphite in cellulose solutions of 4.10^{-2} Ω.cm [3]. The reports in literature show comparable thermal conductivity results: 11,2 W/m.K for graphene/epoxy polymer composites in the cross-plane direction [4]. Preliminary results obtained here in development of nanocomposites based on multi-layer graphene with polymers, show good performance compared with the results in literature.

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