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Graphene and water-based elastomers thin-film composites

Elastomers are viscoelastic polymers with weak inter-molecular forces that exist in an amorphous state above their glass transition temperature. Elastomers can be classified as thermosets or thermoplastics. The most common thermoset elastomer is vulcanized natural rubber latex (NRL), which is most commonly processed in the form of a latex, a stable dispersion (emulsion) of polymer microparticles in an aqueous medium. Also common are thermoplastic polyurethanes (PU), in this case an anionic aliphatic polyester polyurethane dispersion in water.

We demonstrate composites with both graphene oxide and reduced graphene oxide, the reduction being undertaken in-situ or ex-situ using a biocompatible reducing agent in ascorbic acid. The graphene/wPU composite incorporates graphene flakes in between polymer chains, whereas the graphene/NRL composite incorporates the graphene in between polymer microparticles. The ultrathin films were cast by dip molding. The transparency of the elastomer films allows us to use optical microscopy image and confirm the uniform distribution as well as the conformation of the graphene flakes within the composite.

We show that graphene can be used to reinforce 20 micron thin elastomer films, resulting in over 50% increase in elastic modulus at a very low loading of 0.2 wt%, while also increasing the elongation to failure. This loading is below the percolation threshold for electrical conductivity.

Thin-film elastomers (elastic polymers) have a number of technologically significant applications ranging from sportswear to medical devices.

References

[1] Iliut, M.; Silva, C.; Herrick, S.; McGlothlin, M.; Vijayaraghavan, A.; *Carbon*, **2016**, 106, 228-232

Figures

Figure 1: Optical images of water-borne polyurethane thin-films reinforced with 0%, 0.05%, 0.1% and 0.2% by weight of reduced graphene oxide.