Graphene/Polymer Nanocomposites: New Materials with Improved Functional Properties)

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A new era of bio-based polymers replacing existing synthetic polymers has been growing at a tremendous speed. The interest in bio-renewable polymers further increased since some countries have banned single-use plastics for daily use, for example United Arab Emirates. Following the world patterns, companies such as Coca Cola are in line to change extensively consumed PET polymer with a bio-based alternative to share the global efforts in reducing synthetic polymer consumption. Bio-renewable poly (ethylene furandicarboxylate) (PEF) has been regarded as a possible substitute of PET for different applications. Being a new polymer in the market awaiting its commercial production line, PEF has to be studied towards various applications in the polymer market or at least within the application areas of PET.

This presentation is focused on our recent results on blending PEF with other potential polymers to improve its functional properties. Blends of PEF with synthetic polyolefins and bio-based poly (lactic acid) (PLA) and their nanocomposites were developed. The results are periodically benchmarked against standard PET to delineate a picture of practicality of the research results. Typically used commercial compatibilizers were incorporated to develop a thin interface between PEF and polyolefins whereas the concentration of the compatibilizers controlled the final morphology of the blends. The relations between on the one hand component properties and processing conditions and on the other hand blend morphology were rationalized based on classical theories for morphology development of polymer blends.

In the second part of this work, graphene nanosheets and single wall carbon nanotubes were locked at the interface of co-continuous PEF blends to produce electrically conductive composites. Owing to the development of an extremely thin polymer/polymer interface, a very small amount of nanofillers was able to electrically percolate the blend matrix. Moreover, conductive blends with changing blend ratio and graphene concentration are reported. In addition, membranes developed from PEF blends using electrospinning will be presented with unique switchable emulsification and demulsification applications in water-in-oil emulsions. More work is underway to predict filler packing at the polymer/polymer interface which will help in engineering conductive blends based on renewable polymers for mass applications.

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