**Effect of Filler Size in a Graphene-Anthracene Carbon-Carbon Composite**

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Abstract

Carbon-carbon (C-C) composites are lightweight materials that can perform structurally at extreme temperatures and have superior thermal shock, toughness, ablation, and heat shielding applications. Our goal is to show that carbon allotropes as additives can be used to direct the nano- and microstructure of C-C composites to tailor properties for these varied applications. In this work C-C composites are characterized across multiple length scales to demonstrate such control in relation to macro-scale properties. This work characterizes both graphene-anthracene and novalac-graphene C-C composites from the nano- to the micron-scale with a variety of analytical techniques brought to bear. Three variations of the graphene-anthracene composite are prepared by using graphene sheets of varied sizes as a filler in each matrix. The graphene materials included 300-800 nm reduced graphene oxide, 1-2 um graphene nano-platelets and 2-5 μm graphene. The composites are prepared by first carbonizing the mix at 500 °C in a sand bath followed by high temperature heat treatment in a graphitization furnace at 2700 °C. The carbon-carbon composites so formed are then characterized at different length scales to understand the graphene additives' influence on the composites' bulk properties. Polarized light microscopy, SEM, TEM and XRD illustrate a decreasing degree of graphitization with decreasing graphene platelet size for the anthracene composite while a novalac-based char is observed to developed graphitization behavior with increasing graphene platelet size. These results illustrate control of the graphitization degree and direction – dependent upon graphene platelet size and matrix precursor.