Permittivity of Dielectric Composite Materials Comprising Graphene Nanoribbons. The Effect of Nanostructure—Supporting Information

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Distribution of GNRs in the polymer host

The distribution of GNRs was analyzed by optical microscopy of thin layers of liquid composite sandwiched between two microscope slides. All three types of composites: K-split MWCNT/NuSil, K/Na-unz GNR/NuSil and HD-GNR/NuSil have nearly uniform dispersion with individual GNRs easily identifiable under high magnification. Circular aggregate clumps are sporadically seen in all the three composites. In order to assess the difference in number of aggregate clumps with the type of GNR used, aggregates were individually counted and measured using a digital ruler in a number of images taken by the microscope. All photographs taken for aggregate counting were recorded at 10× magnification with a width of 1368 μm and a height of 1105 μm. A clump was considered an aggregate if it was larger than or equal to a circle with a 20 μm diameter. The analytical results show that there exists a small difference between the three types of composites.

At 0.5% composite loading, 16 pictures were systematically taken in a 4 × 4 grid in the center of the sample. The entire sample set approximately represents 10% of the sample size. K-split MWCNT/NuSil had an average of 2.0 aggregates per picture with an average diameter of 31.0 μm. HD-GNR/NuSil had an average of 1.3 aggregates at a comparable diameter of 31.7 μm. K/Na-unz GNR/NuSil had 4.5 aggregates with an average size of 29.1 μm. Figure 1 shows photos of typical distributions at 0.5% loading. Thus, the highest number of aggregates were found in K/Na-unz GNR/NuSil, and the lowest number was found in HD-GNR/NuSil. Despite the difference, the aggregation concentration was so small in all three types of composites that their effect upon the macroscopic behavior of the composites was insignificant.

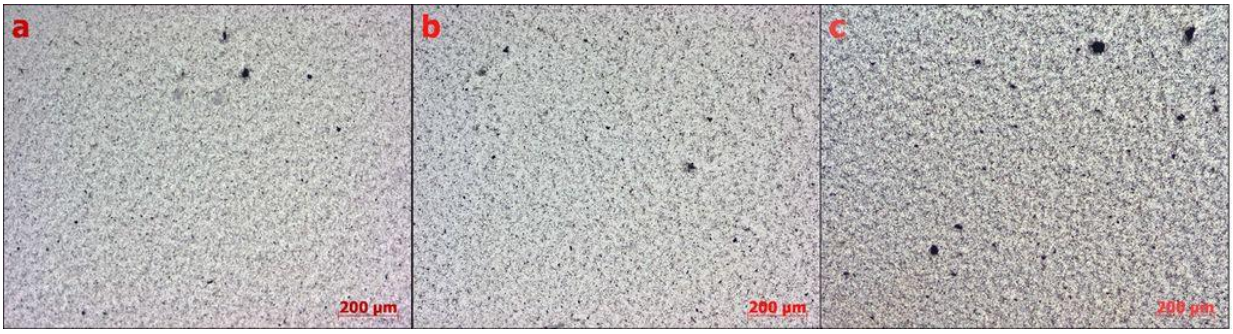

Figure S1. Microphotographs of the composites with 0.5% filling fraction of (a) K-split MWCNT, (b) HD-GNR, (c) K/Na-unz GNR. The photographs were taken in transmitted light from the thin layers of liquid composites.

Density of GNRs

Density values for GNRs are needed to convert the wt% of inclusions used to prepare composites into their volume fractions, the most common way of presenting data in related studies. The density of a sample of GNRs produced in this study was measured using a Setaram PCT Pro Sievert's-type gas adsorption apparatus and was found to be 2.11 g/cc^3.