Highly-aligned 2D and cellular interconnected 3D graphene/polymer composites with exceptional multi-functional properties

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This presentation reports the optimized process for fabricating ultralarge GO (UL-GO) sheets from natural graphite flakes. UL-GO sheets with maximum area over 10,000 μm^2 and a mean area 3400 μm^2 at a yield of 40% for GO sheets larger than 2500 μm^2 are achieved. The UL-GO sheets are capable of spontaneously self-assembling into lyotropic nematic liquid crystals in water above a critical concentration of about 0.1 wt% [1]. The UL-GO sheets are applied as basic building blocks for several graphene-based 2D bulk materials with a highly ordered layer structure, including graphene papers [2], graphene thin films, and aligned graphene composites [3]. The composites containing self-aligned UL-GO sheets exhibit anisotropic properties with higher strength and modulus in the alignment direction, as well as high dielectric constants and excellent electromagnetic wave shielding efficiencies. It is also shown that multilayer graphene enables efficiency in improving thermal conductivities of graphene/epoxy composites [4].

3D graphene materials with interconnected architectures are prepared using different techniques, including template-based graphene foam (GF), and freeze-dried graphene aerogel (GA). Compared with 2D graphene, these 3D materials exhibit many unique properties, including exceptional electrical conductivities, ultralow densities, as well as excellent elasticity and flexibility. The GF/epoxy composites consist of a highly porous, cellular structure and the 3D interconnected graphene network serves as the channel for uninterrupted movement of charge carriers, achieving a remarkable electrical conductivity of 3 S/cm with only 0.2 wt% GF [5]. The GF/poly(dimethyl siloxane) (PDMS) composites hybridized with carbon nanotubes possess a remarkable electromagnetic interference shielding effectiveness of 75 dB. The highly-oriented, unidirectional GA/epoxy composites present an excellent electrical conductivity of 2×10^{-3} S/cm after incorporating 0.25 wt% graphene with an extremely low percolation threshold of 0.007 vol%, which is the lowest for all graphene/polymer composites reported in the literature [6].

References

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Short Bio

Prof. Kim is currently a Chair Professor at Hong Kong University of Science and Technology (HKUST) and directs the Finetex-HKUST R & D Center and the Advanced Engineering Materials Facilities. Kim's research is centered on advanced materials, ranging from fiber-reinforced composites to nanocomposites containing graphene and carbon nanotubes, and to nanostructured materials for energy storage devices and multi-functional applications. Kim has written over 300 refereed journal papers with over 11,000 citations (by WoS) and 3 research monographs on fiber composites, nanocomposites and graphene thin films; and edited 8 books and holds 7 patents. He has been serving as the Editor of *Composites Part A* and as the Associate Editor of *Aerospace Science and Technology* in addition to editorial board members of another 12 journals. He is a fellow of RSC and HKIE.