

ABSTRACT

Advanced Nanocomposites from Carbon nanotube and Graphene for Potential Aerospace Applications

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Carbon nanotubes (CNTs) and graphene exhibit an exceptional combination of electrical and mechanical properties [1], making them ideal for advanced nanocomposite manufacturing. However, high quality and large-scale synthesis of CNT and graphene remains a challenge for industrial applications. To address this, we developed a novel gas-phase reactor-based process for the continuous large-scale synthesis of CNT and graphene films/fibers. The resulting CNT/Graphene Films demonstrate high strength, modulus [2] and excellent electrical conductivity [3].

To explore their applications, we fabricated multi-scale composites by incorporating aligned CNT films—directly spun from the gas-phase reactor—as a coating layer on carbon fibre prepregs. These composites were manufactured using conventional vacuum bagging techniques widely adopted in industry. The hybrid CNT/carbon fibre composites, with CNT film coatings, exhibited remarkable surface conductivity with just two layers of CNT fibers [4]. Preliminary electrical tests suggest that this approach enables scalable integration of CNTs into engineering structures, with potential applications in aerospace engineering, such as lightning strike protection and electromagnetic interference (EMI) shielding.

Additionally, we developed graphene-based polymer nanocomposites with enhanced fracture toughness and shear strength, offering promising applications in graphene enhanced polymer adhesives for joining composite structures in aerospace and other engineering fields.

References:

1] "The mechanical and electrical properties of direct-spun carbon nanotube mats", Extreme Mechanics Letters, Volume 21, May 2018, Pages 65-75

2] "High-performance carbon nanotube fiber", K Koziol, et al, Science 318 (5858), 1892-1895

3] "Electrical properties of carbon nanotube-based fibers and their future use in electrical wiring", Lekawa-Raus, et al, Advanced Functional Materials 24 (24), 3661-3682

4] Carbon nanotube films spun from a gas phase reactor for manufacturing carbon nanotube

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film/carbon fibre epoxy hybrid composites for electrical applications, Chen et al, Carbon, 158, 2020, 282-290