Enhancing Thermal Conductivity and Flame Resistance of Carbon Fiber Composites using CNT-infused Multiphase Graphene Resins

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Supplementary Information

Table S1: *Compositions of different epoxy composites and MINETs*

Sample	Epoxy [g]	Particles [g]	Surfactant [a] [g]	Working fluid [g]	CNT [g]
Epoxy (control)	0.80				
Epoxy Graphene	0.80	0.125			
Epoxy CNT	0.80				0.06
Graphene MINET Canola oil	0.80	0.50	0.1	1	
Graphene MINET CNT Canola oil	0.80	0.50	0.1	1	0.06
Graphene MINET Silicone oil	0.80	0.50	0.1	0.96	
Graphene MINET CNT Silicone oil	0.80	0.50	0.1	0.96	0.06

[a] The canola oil surfactant is epoxidized soybean oil (ESO), and the silicone oil surfactant is dimethylsiloxane copolymer (DBP-732).

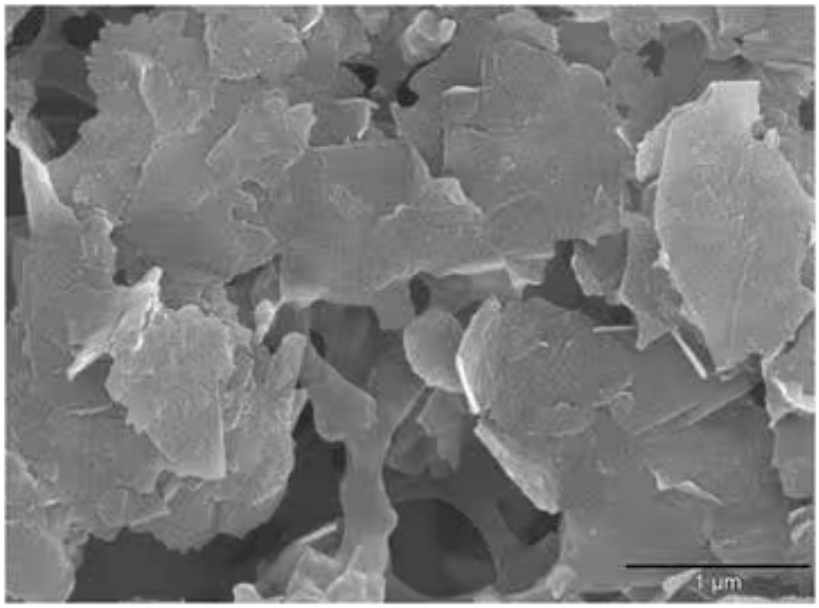

Figure S1: *SEM image of graphene particles (Skyspring nanomaterials)*

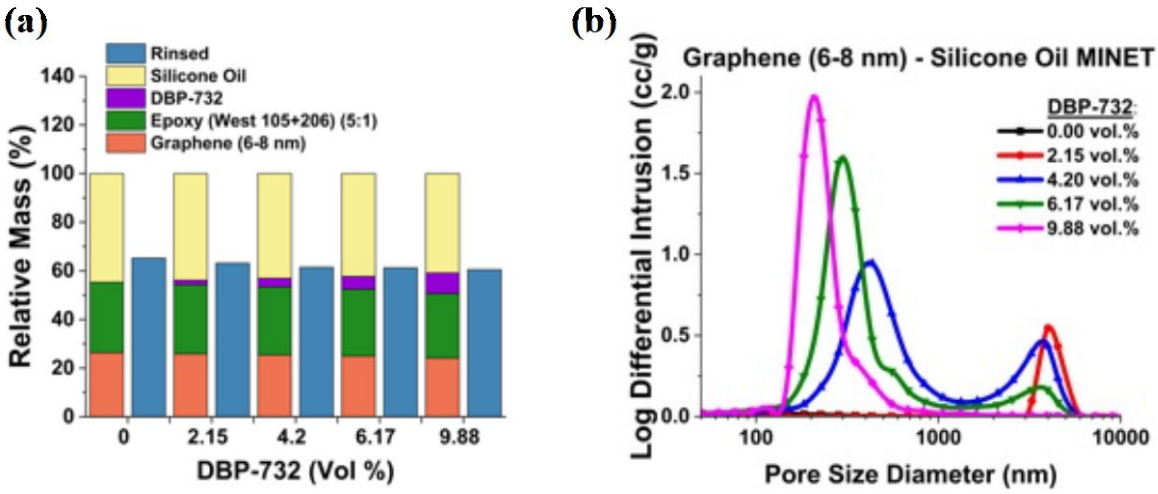

Figure S2: *(**a**) Mass loss for graphene particles and silicone oil-based composite samples as shown by component masses (left bar) and mass of final composite after hexane rinsing (right bar). Both bars were normalized to the total component mass. (**b**) Mercury porosimetry results for the samples are shown in (**a**). The curves represent the change in intruded pore volume, dv/dlog(d), as a function of pore diameter, d.*

Table S2: *Mechanical properties of various CFC epoxy composites. Samples were evaluated through tensile testing, conducted in accordance with a modified ASTM D3039 standard using an Instron 4411 testing machine. Moduli extracted from peak load and displacement for N=3 samples.*

Sample	Tensile Modulus (GPa)
CFC Control	10.34 ± 0.83
CFC MINET (canola oil)	3.47 ± 0.39
CFC MINET (silicone oil)	3.8 ± 0.42

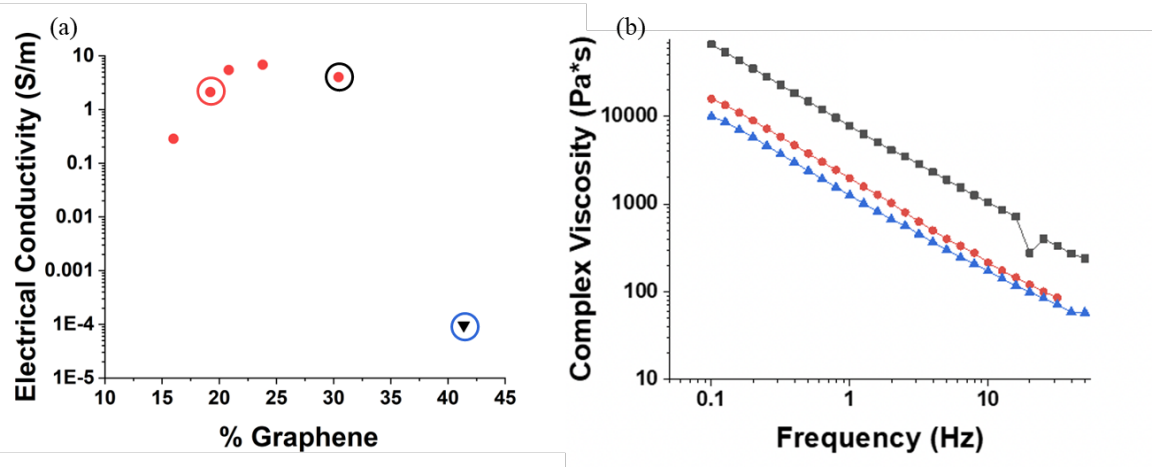

Figure S3: *Results from a preliminary compositional study on the co-optimization of electrical conductivity and processability in graphene-based MINETs.* ***(a)*** *Two-point probe electrical conductivity measurements of canola oil and graphene-based MINETs. Red points are from samples composed of the same particles as used in this study while black particles are a smaller variety from the same supplier.* ***(b)*** *Viscosities of select samples marked with colored circles in* ***(a)*** *as measured by a TA DMA 850 shear plate. MINET compositions near 20% graphene particles have similar electrical conductivities as higher loadings despite simultaneously displaying much lower viscosity, leading to their selection for further investigation in this current work.*

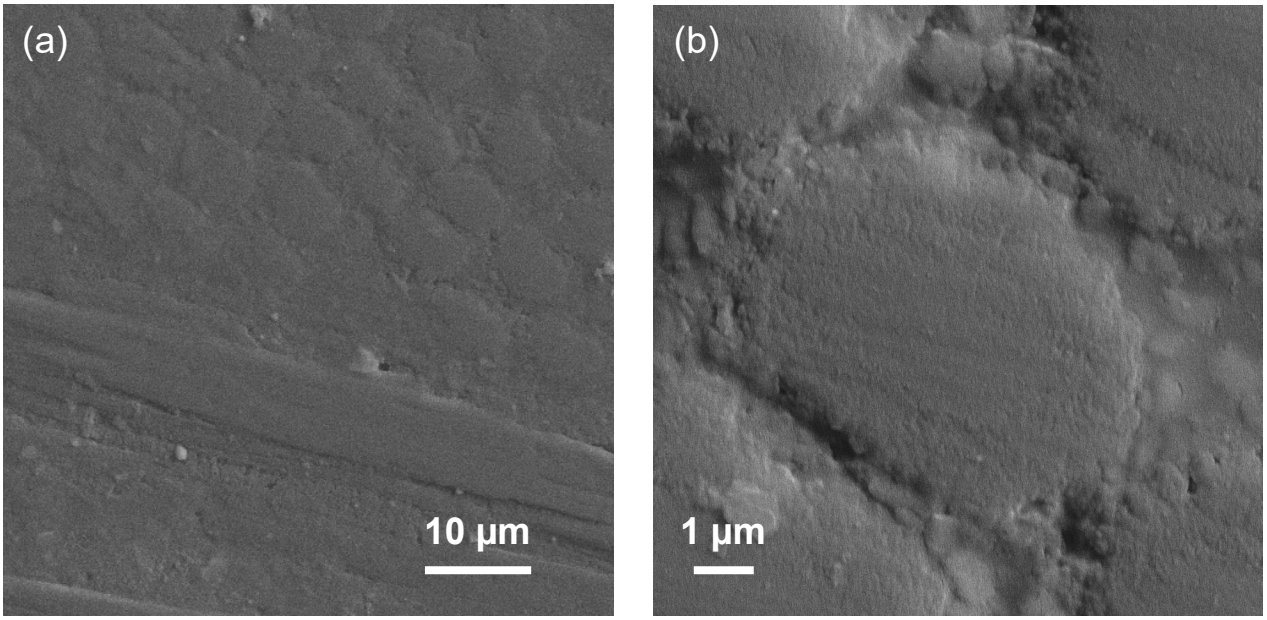

Figure S4: *Characteristic* ***(a)*** *Wide and* ***(b)*** *narrow field images of a polished cross-section of a silicone oil CFC MINET-CNT sample after embedding in an EPON 828-PACM resin block and polished up to 1200 grit. While the fibers and graphene flakes embedded in the resin and silicone oil can be easily resolved, no CNT bundles or CNTs were observed.*

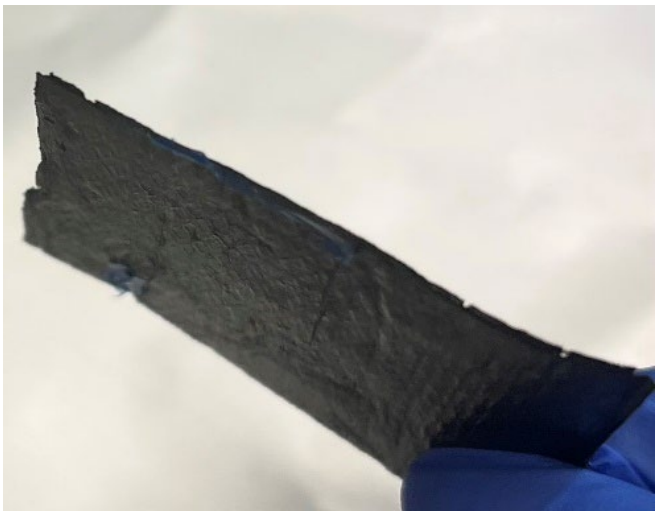

Figure S5: *A photograph of a CFC sample fabricated using graphene MINET as the matrix material and molded together with commercial prepreg fibers. The CFC samples, stored at -30 °C for two weeks, remained flexible and uncured upon removal, and became solid after thermal curing at 100 °C for two hours.*

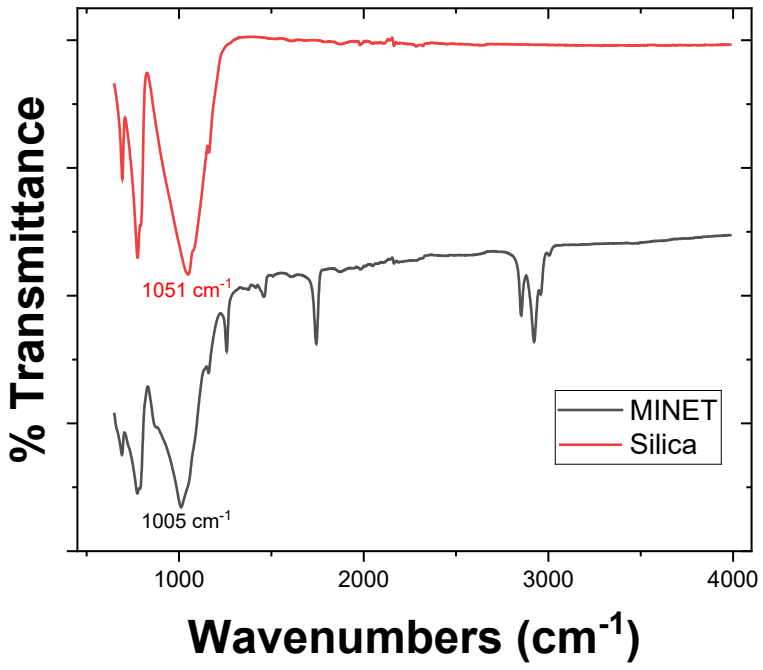

Figure S6: *FTIR results for burned silicone oil MINET samples and silica nanoparticles.*