Liquid Phase Exfoliation of GRMs & Their Applications in Space and Beyond

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Two-dimensional (2D) materials flakes offer a range of exploitable electrical, thermal, and mechanical properties that make them attractive as performance enhancing additives, especially in energy storage, composites, inks, and coatings among others [1-4]. Thus far, the most promising method for affordable, industrial scale 2D flake production is liquid phase exfoliation (LPE). However, the state-of-the-art LPE techniques have challenges including but not limited to purification processes, large solvent volumes due to lower concentrations, unexfoliated material waste due to lower yield, lower flake sizes (typically hundreds of nanometres) and inadequate bulk characterization techniques, which lead to the widespread unreliability of 2D materials product specifications, increased costs, and limited process-property control [5].
Here I will talk about the production of 2D materials inks and suspensions via High Pressure Homogenization (HPH) based techniques [6] with a capability of producing flakes at higher concentrations (> 500 g/L) with no post-processing or purification and with semi-controllable properties. Through post solvent exchange 2D materials inks and suspensions can be produced nearly in any solvent. 2D materials such as graphene, hexagonal boron nitride and molybdenum disulphide are produced in water, ethanol, isopropanol, and for the first time in unconventional solvents such as hydrofluoroether (HFE) without fluorine functionalization. HFE is chosen due to its safety features in Space applications [7]. The use of these 2D materials inks suspended uniformly in HFE in microgravity conditions is demonstrated aboard sounding rockets (MASER14, and MASER15) [8, 9].

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