Emulsions stabilised by graphenes: Pickering, the next generation?

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It has recently been seen that graphene oxide and related 2-dimensional nanomaterials can stabilise emulsions and foams at a fraction of the material cost when compared to the conventional 3D (usually spherical) particles employed for Pickering/Ramsden emulsification. Emulsions stabilised by graphene oxide show remarkable stability, and can be tuned by changes in solution conditions, making them interesting candidates for a range of applications.

We have shown that such emulsions are exquisitely sensitive to the parameters used during their formulation, which affect the interactions between graphene oxide and the oil–water interface: pH, salt, oil type, and the presence of other additives. Their stability to dilution is particularly appealing when compared to molecularly stabilised emulsions.

By employing a range of techniques including tensiometry, X-ray reflectometry and atomic force microscopy, we have started to uncover the mechanism by which graphene oxide stabilises emulsion droplets, finding a subtle balance of charge, hydrophobicity and configurational effects at play. Such understanding allows for optimisation of emulsification conditions, and for the production of smart systems for capture and release.

In most cases, emulsification of oil in water with graphene oxide gives simple oil-in-water emulsions. However, for certain oils, carefully engineered solution conditions result in single-step production of multiple emulsions, leading readily to multi-compartment capsules through polymerisation of the outer droplet interface. Controlling the outer 'skin' of these capsules allows for controlled release of active agents contained within, with potential applications in agriculture and water treatment.