One-step exfoliation and biofunctionalization of 2D-materials

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The manipulation of graphene surface functionalization using amphiphilic surfactants during liquid phase exfoliation opens opportunities in various fields, particularly in biomedical applications, where graphene gains enhanced compatibility and hydrophilicity with a new unique biological fingerprint [1]. Surfactants like SDS, Tween, Triton-X, polyvinylpyrrolidone (PVP), and, less commonly known, phospholipids (PLs) can be used for graphene exfoliation. Despite their potential in surface engineering due to structural similarities and preferred interactions with carbon materials [2], PLs are underutilized. PLs can form various structures, such as hexagonal phases, micelles, and vesicles, resulting in different surface energies and interactions based on solvent solubility parameters. This study examines the effect of PLs on graphene exfoliation and coating. For the first time, we report the distinct surfactant-coated surface morphologies of few-layer graphene (FLG) during liquid-phase exfoliation, both before and after gold coating. The study reveals that PL features around FLG vary with solvent polarities, leading to differences in coating patterns. Besides, by leveraging the surface energies of graphene and its gold dewetting behaviour, we introduce a new and easier platform for visualizing surfactant coating and forming self-assembled gold patterns. Unlike conventional methods like thermal and laser dewetting [3], this new surfactant templating approach is much easier, producing a wide range of morphologies, from isolated islands (Fig. 1D (ii)) to percolated networks (Fig. 1A (iii)), which can be used for various applications, such as improving surface plasmon resonance (SPR) and other gold-based biosensors' sensitivity.

References

[1] Y. He et al., Advanced materials, 2024
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Figures

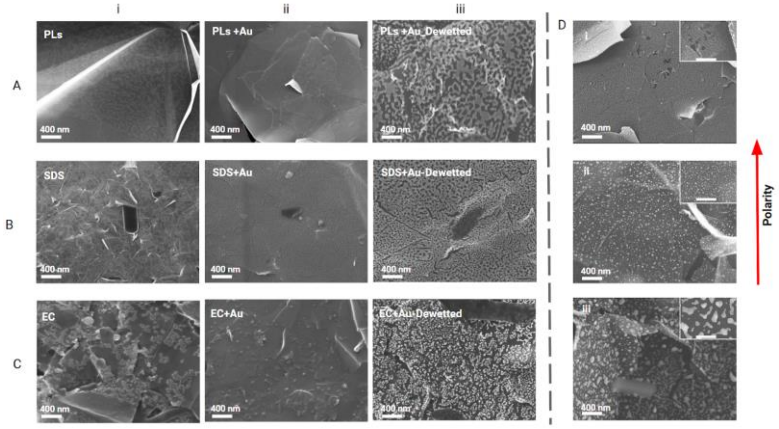

Figure 1: SEM showing surface morphology and dewetting behaviour of graphene coated with (A) lipids, (B) SDS, (c) SDS and Ethyl cellulose, where (i) there is no gold coating, (ii) directly after gold coating, (iii) dewetting of gold after equilibrium is reached. (D) shows the effect of solvent polarity on the stability of dewetting and interaction of PLs with the gold layer, where graphene exfoliated with PLs in a solvent with (i) high polarity, (ii) medium polarity, (iii) and low polarity (inserts show a scale bar of 100 nm).