Graphene-based membranes and flexible technologies

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Graphene and two-dimensional crystals find applications across water purification, energy generation and storage, and sensing technology. The transition from laboratory research to market readiness requires reliable, scalable, and sustainable production methods. While liquid phase exfoliation (LPE) appears potentially suitable for cost-effective mass production, its scalability is hampered by the recurrent use of hazardous solvents.[1,2] Here, we produced stable dispersions of few-layer graphene flakes by using high-shear mixing in dihydrolevoglucosenone (Cyrene), an eco-friendly solvent.[3,4] We fabricated graphene-based nanofiltration membranes on polyvinylidene fluoride supports by vacuum filtration, which demonstrated extraordinary stability under prolonged soaking in water with no swelling. The membranes showed charge- and size-selective properties, with high anion selectivity and 96% rejection rate for the antibacterial agent tetracycline, and significantly reduced the bacterial adhesion compared to standard reverse osmosis membranes.[5,6] The nanofiltration performance stems from the complex nanochannel structure of the membrane, whose interlayer spacing governs the selectivity and permeability.

As a second example of innovative filtration technology, the LPE graphene flakes were integrated in the design of carbon molecular sieve membranes,[7] increasing their permselectivity in pervaporation-based dehydration of propionic acid.

Lastly, we implemented high-pressure airless spray exfoliation to further increase the graphene flake yield, reaching 1 L/h production rate (1.5 mg/mL). As-produced graphene powder was transformed into a conductive, eco-friendly paste to fabricate electrodes for flexible micro-supercapacitors, as well as high-performance coatings for electromagnetic interference shielding and wearable strain sensors.[8]

References

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