

Graphene and 2D Hybrid Systems

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The future research and application of graphene and 2D materials urgently calls for the efficient chemical synthesis and processing. In this lecture, top-down solution exfoliation of high-quality graphenes is firstly presented which relies on smart processing of graphitic materials at the different thickness level under electrochemical control. This strategy offers the possible means to produce high quality graphene, on a large scale, at low cost, and in a reproducible manner. In order to open up the band gap of graphene, a lateral confinement must be introduced, therefore, a bottom-up synthetic route will be demonstrated which offers well-defined nanographenes and graphene nanoribbons with tailor-made properties at the molecular level. This synthetic strategy is based upon the cyclodehydrogenation ("graphitization") of well-defined dendritic (3D) polyphenylene precursors with different topologies, either by solution- or surface-mediated synthesis. We will further discuss the rational assembly of graphene sheets offering the fabrication of carbon and related 2D nanohybrid materials with different complexities. Finally, we will present some prominent applications with using these graphene materials as well as their nanohybrids across the fields of organic electronics, transparent electrode, fuel cells, supercapacitors and micro-supercapacitors as well as batteries.