Porphene - a Heterocyclic Analog of Graphene

Josef Michl

Department of Chemistry, University of Colorado, Boulder, CO, USA, and Institute of Organic Chemistry and Biochemistry, Czech Academy of Sciences, Prague, Czech Republic

Controlled oxidative coupling of zinc porphyrin on the surface of an aqueous subphase in a Langmuir-Blodgett trough yields a bilayer of porphene, a fully conjugated two-dimensional polymer with fourfold symmetry. Its structure was proven by in-situ grazing incidence X-ray diffraction and is analogous to that of graphene, but porphene is composed of fused porphyrin rings while graphene is composed of fused benzene rings. The synthesis yields large (>0.1 mm across) sheets of a porphene bilayer. Investigations of porphene formation mechanism and its spectroscopic, structural, electrical, chemical, and mechanical properties, as well as exfoliation to single sheets and construction of twisted multilayer sheets using bidentate ligands, are currently underway. The ability of the porphyrin macrocycle to bind many different kinds of metal cations carrying two, one, or no additional ligands promises that porphene will not be a single polymer but rather, a large family of two-dimensional polymers with tunable properties. Here, porphene differs from graphene in that its functionalization does not require taking any of its π-electron centers out of conjugation, and merely involves insertion of metal ions into its macrocycles and attachment of arbitrary ligands. It is therefore expected that it will be at least as versatile as graphene.