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Physics and Chemistry of Molecule-Based Mimics of Carbon Allotropes

Prof. Kunio AWAGA, *Research Center for Materials Science, Nagoya University, Japan*

Recently, graph theory has predicted the K4 structure as a new allotrope of carbon, in addition to diamond, graphite, graphene, fullerenes and nanotubes. This K_4 structure consists of a 3D chiral network, which is identical to the srs net in crystallography, and is also isostructural to the single gyroid in mathematics and soft-material research. Although the band calculation on K4 carbon predicts a metallic ground state and the presence of Dirac cones, attempts to synthesize the K4 carbon have not succeeded. From this perspective, it is important to mimic the structures of carbon allotropes, using molecular materials, and to reproduce their unique electronic structures. In this presentation, we report our efforts to make molecule-based mimics of carbon allotropes, showing their unusual physical properties, such as spin frustration, spin liquid state, and Dirac cones. We also explain the band-filling control by means of solid-state electrochemistry.