Seminar #13 November 27, 2020, 11:30 am

Bottom-Up Chemical Synthesis of Atomically Precise Graphene Nanostructures

Akimitsu Narita

OIST – Okinawa Institute of Science and Technology Graduate University

Nanostructures of graphene, such as quasi-zero-dimensional graphene quantum dots (GQDs) and quasi-one-dimensional graphene nanoribbons (GNRs) have been targets of theoretical studies, which predicted their unique optical, electronic, and magnetic properties. Such properties are critically dependent on their chemical structures, which makes it essential to synthesize GQDs and GNRs with atomic precision. However, the predominant top-down fabrication methods, as represented by lithographic patterning of graphene, have failed to achieve the required accuracy in their structural control. In contrast, large polycyclic aromatic hydrocarbons (PAHs) obtained by the methods of synthetic organic chemistry can be regarded as atomically precise GQDs and the bottom-up molecular synthesis has enabled the preparation of structurally well-defined GNRs. This seminar will describe the chemical synthesis and characterization of GQDs and GNRs with various structures, and introduce their unique structure-property relationship and potential applications. For example, dibenzo[hi,st]ovalene (DBOV) as a highly stable GQD with a combination of armchair and zigzag edges showed strong red fluorescence, stimulated emission, and amplified spontaneous emission, making it promising for lasing and bioimaging applications. Moreover, GNRs with different widths could be synthesized, demonstrating the modulation of the bandgap energies, and the accurate control of their edge structures led to the emergence of unique quantum electronic states.

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