Synthesizing single-crystalline hexagonal graphene quantum dots

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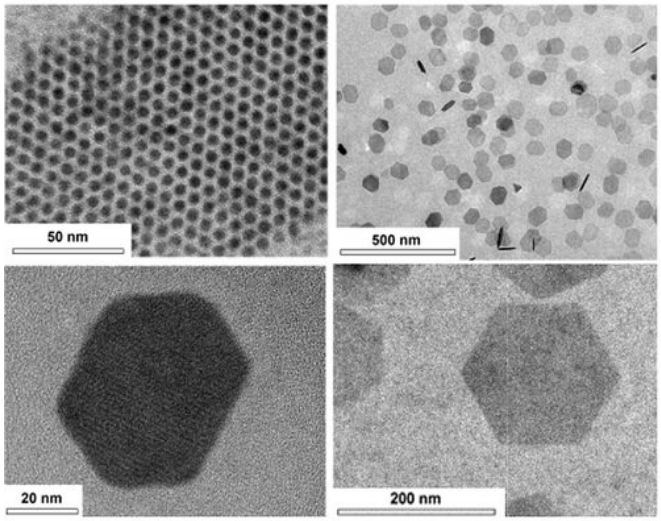

Uniformly ordered single-crystalline graphene quantum dots of various sizes synthesized through solution chemistry. Credit: KAIST

A KAIST team has designed a novel strategy for synthesizing single-crystalline graphene quantum dots, which emit stable blue light. The research team confirmed that a display made of their synthesized graphene quantum dots successfully emitted blue light with stable electric pressure, reportedly resolving the long-standing challenges of blue light emission in manufactured displays. The study, led by Professor O Ok Park in the Department of Chemical and Biological Engineering, was featured online in *Nano Letters* on July 5.

Graphene has gained increased attention as a next-generation material for its heat and electrical conductivity as well as its transparency. However, single and multi-layered graphene have characteristics of a conductor so that it is difficult to apply into semiconductor. Only when downsized to the nanoscale, semiconductor's distinct feature of bandgap will be exhibited to emit the light in the graphene. This illuminating featuring of dot is referred to as a graphene quantum dot.

Conventionally, single-crystalline graphene has been fabricated by chemical vapor deposition (CVD) on copper or nickel thin films, or by peeling graphite physically and chemically. However, graphene made via chemical vapor deposition is mainly used for large-surface transparent electrodes. Meanwhile, graphene made by chemical and physical peeling carries uneven size defects.

The research team explained that their graphene quantum dots exhibited a very stable single-phase reaction when they mixed amine and acetic acid with an aqueous solution of glucose. Then, they synthesized single-crystalline graphene quantum dots from the self-assembly of the reaction intermediate. In the course of fabrication, the team developed a new separation method at a low-temperature precipitation, which led to successfully creating a homogeneous nucleation of graphene quantum dots via a single-phase reaction.

Professor Park and his colleagues have developed solution phase synthesis technology that allows for the creation of the desired crystal size for single nanocrystals down to 100 nano meters. It is reportedly the first synthesis of the homogeneous nucleation of graphene through a single-phase reaction.

Professor Park said, "This solution method will significantly contribute to the grafting of graphene in various fields. The application of this new graphene will expand the scope of its applications such as for flexible displays and varistors."

More information: Seok Hwan Lee et al. Synthesis of Single-Crystalline Hexagonal Graphene Quantum Dots from Solution Chemistry, *Nano Letters* (2019). DOI:

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