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Anomalous Behaviors of Visible Luminescence from Graphene Quantum Dots

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Abstract : For the application of graphene quantum dots (GQDs) to optoelectronic nanodevices, it is of critical importance to understand the mechanisms which result in novel phenomena of their light absorption/emission. The optical transitions are known to be available up to ~6 eV in GQDs, especially useful for ultraviolet (UV) photodetectors (PDs). Here, we present size-dependent shape/edge-state variations of GQDs and visible photoluminescence (PL) showing anomalous size dependencies. With varying the average size (da) of GQDs from 5 to 35 nm, the peak energy of the absorption spectra monotonically decreases, while that of the visible PL spectra unusually shows nonmonotonic behaviors having a minimum at diameter ~17 nm. The PL behaviors can be attributed to the novel feature of GQDs, that is, the circular-to-polygonal-shape and corresponding edge-state variations of GQDs at diameter ~17 nm as the GQD size increases, as demonstrated by high resolution transmission electron microscopy. We believe that such a comprehensive scheme in designing device architecture and the structural formulation of GQDs provides a device for practical realization of environmentally benign, high performance flexible devices in the future.

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