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Carbon Quantum Dots for Multi-Potential Applications

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Perspective

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PERSPECTIVE

Carbon Quantum Dots (CQDs)/carbon nanodots are a replacement class of fluorescent carbon nanomaterials having an approximate size within the range of 2 nm–10 nm. The bulk of the reported review articles have discussed about the event of the CQDs (via simple and cost-effective synthesis methods) to be used in bio-imaging and chemical/biological-sensing applications. However, there's a severe lack of consolidated studies on the recently developed CQDs (especially doped/co-doped) that are utilized in several areas of application. Hence, during this review, we've extensively discussed about the recent development in doped and co-doped CQDs (using elements/heteroatoms e.g., boron (B), fluorine (F), nitrogen (N), sulphur (S), and phosphorous (P)), alongside their synthesis method, reaction conditions, and/or Quantum Yield (QY), and their emerging multi-potential applications including electrical/electronics (such as Light Emitting Diode (LED) and solar cells), fluorescent ink for anti-counterfeiting, optical sensors (for detection of metal ions, drugs, and pesticides/fungicides), gene delivery, and temperature probing.

To summarize, it are often noted that there are sizable amount of investigations that involve within the effective preparation and optimization of doped and co-doped CQDs. The hydrothermal method is much utilized within the synthesis of those doped and co-doped CQDs as compared to other synthesis methods. Nevertheless, there are more avenues to explore within the preparation and optimization of those doped and co-doped CQDs via different synthesis protocols in near future, when comparing with the preparation methods of normal CQDs (without doping).

Moreover, supported the above discussed research-investigations, a clear observation is that:

- the precursors alongside the sort of synthesis method (including the reaction conditions like response time and/or temperature)
- the sort of doping have an excellent impact on the resultant Quantum Yield (QY) of the as-synthesized doped and co-doped CQDs

However, in many research studies, the explanations behind the enhancements within the QY within the doped and co-doped CQDs as compared to the traditional CQDs aren't completely evaluated. Thus, in near-future, it should be possible to obviously understand the inherent photoluminescence phenomenon within the doped and co-doped CQDs.

Furthermore, above 85% of the as-synthesized doped and co-doped CQDs has emitted blue fluorescence. Hence, the doped and co-doped CQDs with multi-colour emissive properties are often explored and consequently utilized in several applications in future.

Besides the above, it's been confirmed that the doped and co-doped CQDs are often effectively utilized in several applications including electrical/electronics (such as LED and solar cells), fluorescent ink for anti-counterfeiting, optical sensors (for detection of metal ions, drugs, and pesticides/fungicides) including molecular logic gates, gene delivery, and temperature probing. However, the extent of exploitation of those doped and co-doped CQDs during a big variety of applications (including the biological applications) is a smaller amount as compared to the traditional CQDs and to the opposite nanoparticles (e.g., super paramagnetic iron oxide nanoparticles (SPIONs)). Supported the above-given studies, it are often concluded that the doped and co-doped CQDs are potential candidates for emerging applications.