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Graphene quantum dots as new molecular guiding lights for bio-imaging and bio-sensing

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Due to the intrinsic limitations suffered by the current fluorophores (e.g., fluorescent proteins, organic dyes, and semiconductor quantum dots), seeking for better fluorescent reporters which are bright, photostable, biocompatible, molecular sized, and of desired excitation-emission profile is an ongoing and critical effort. The emerging graphene quantum dots (GQDs) hold great promise as a new class of superior fluorophores for bio-imaging and optical sensing, owing to their remarkable physicochemcial properties and tunable photoluminescence properties.

In this presentation, new methods to synthesize various GQDs and their applications for cellular imaging and optical sensing are demonstrated. In addition, based on theoretical modeling and calculations, we show that the emission of GQDs can be widely tuned from deep ultraviolet to near infrared by its size, edge configuration, shape, functional groups, defects, and heterogeneously hybridization of carbon network.

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Predictive process planning models for laser cladding and hardening applications

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Laser based applications are utilized in the manufacturing domain typically in the laser cutting and welding domains. Within the mould making industry, there are limited laser based manufacturing operations. Laser engraving is performed; however, with the introduction of high power diode lasers, which have lower running and maintenance costs, this situation has changed and new opportunities have emerged. There is much research and development activity related to laser cladding, and to a lesser extent, laser hardening. Laser cladding can be used to apply a coating of high strength and corrosion resistant materials for long-term reliability and performance, or it can be utilized to repair tools and moulds, turbine engine parts, etc. Laser hardening can be accurately performed on targeted areas to alter the local material hardness without masking or other pre-processing tasks. Unique process planning challenges exist for these processes, which will be discussed in this work. Unlike machining, where there are defined material libraries, process parameter ranges for cutting machine-cutting tool pairs, no coupling between the width and depth of cut, and so forth, the laser cladding/hardening applications have unique challenges to be addressed. There is significant coupling between the process parameters and output results (bead shape, hardening region), conditions change due to the operating environment (base and clad material types, laser spot size, heat profile, etc.), the bead shape changes when overlapping and stacking beads, and so forth. Much research is being performed to understand these issues, and to develop predictive models for effective process planning.

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