Metal-free carbogenic quantum dots for laser generation

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In the last years, intense research efforts have been made in search of new strategic luminescent materials aimed to replace costly rare-earth and toxic metal elements as well as scarce semiconductors. On this account, a unique emerging class of metal-free luminescent materials known as carbon dots (CDs) has been successfully developed via low-cost methods, exhibiting intense photoluminescence and high stability together with excellent biocompatibility and environmental sustainability [1,2]. The outstanding properties of this promising new material has led to the development of proof-of-concept applications in sensing, photocatalysis, and bio-imaging among other fields. However, most of the reported CDs exhibit broad emissions that hinder their implementation in practical applications where commercial semiconductor quantum dots, rare earths and organic dyes are commonly used (LEDs, bio-labeling detection…) [3]. For this reason, CDs systems displaying narrowband emissions are essential to achieve the required technological breakthrough for the development of cutting-edge practical applications.

In this work, we made use of our newly synthetized metal-free, eco-friendly, and low-cost CDs to realize a CDs laser system with reduced linewidth. Sputtered planar nano-photonic structures composed of low-loss materials were assembled to form a Fabry-Perot laser resonator that allow exceptionally high reflectance spectral regions. This architecture realizes an excellent electromagnetic field confinement in the CDs gain media, thus providing optical gain to the system. Upon supplying an adequate amount of pump power, laser threshold is observed and narrow blue laser emission is finally achieved. This new CDs-based laser system constitutes a step forward towards the development of novel eco-friendly and carbon-based light emitting devices (LED) and high-perfomance laser systems.

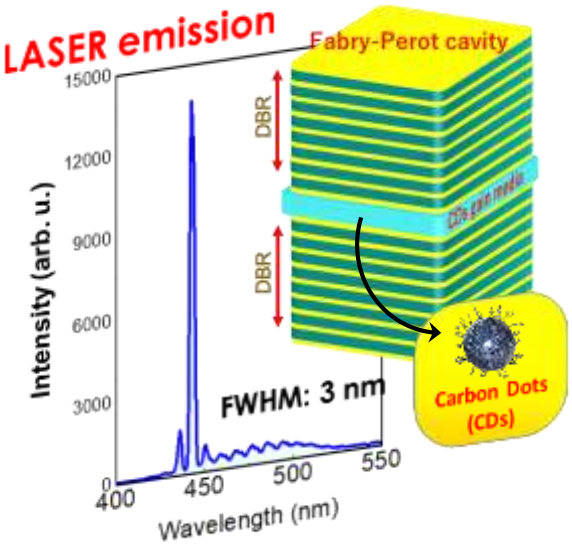

Fig 1. *Experimental narrowband laser emission from a CDs-based Fabry-Perot laser system.*

[1] J. J. Liu et al., ACS Cent. Sci. 6(12), 2179 (2020).

[2] B. K. Barman et al., Appl. Surf. Sci. 510, 145405 (2020).

[3] H. Yu et al., Adv. Mater. 28, 9454 (2016).