Optical investigation of C96 graphene quantum dot

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2D graphene has established itself as an essential material in nanoelectronics thanks to its unique physical and electronic properties but suffers from an incompatibility for semiconductor applications due to its gapless electronic band structure. In this context, graphene quantum dots (GQDs), nano pieces of graphene with non-zero gap, proved to be a fertile playground for controlled tunability of electronic properties. Bottom-up synthesis has enabled a precise control of the size, shape and edges of these objects, a crucial step towards the controlled engineering of their electronic properties [1]. Room-temperature experiments at the single-object level on a C96 triangular GQD (Fig. 1a) have demonstrated bright and stable single-photon emission [2], giving promising prospects for its use as quantum emitter at room-temperature.
Recently, theoretical calculations have revealed that the fluorescence may arise from a symmetry-breaking of the GQD via vibrational deformations of the molecule, enabling appreciable emission from dark states [3]. In the perspective of unravelling the vibrational modes of the molecule, low-temperature single-molecule experiments, necessary to obtain spectral resolution via spectral line-narrowing (Fig. 1b), were carried out on the C96 GQD. Using a robust criterion to discriminate GQDs from environing impurities, GQDs were isolated and characteristic vibrational modes were determined and compared to theoretical predictions [4]. In this presentation, we will show our latest results on the photophysics of GQD at low temperature.

References

[1] R. Rieger & K. Müllen, J. Phys. Org. Chem., 23 (2010), 315-325
[2] S. Zhao et al., Nature Communication, 9 (2018), 3470
[3] T. Liu, C. Tonnelé et al., in preparation
[4] T. Liu, in preparation

Figures

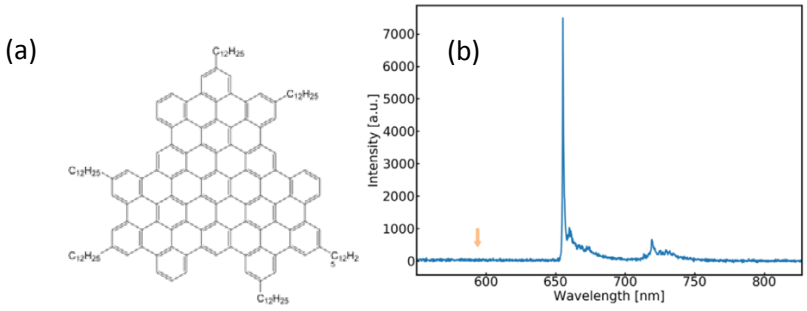

Figure 1: (a) Chemical structure of C96 GQD. (b) Low-temperature (7K) spectrum of C96 GQD (Excited at 594 nm).