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SYNTHESIS AND OPTICAL PROPERTIES OF GRAPHENE QUANTUM DOTS

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Abstract: The outstanding electronic, optical and mechanical properties of graphene strongly inspire the scientific community at both the fundamental and applicative levels. However, one of the main challenges of the field is the control and modification of graphene electronic properties. It is well known that when a material is reduced to nanoscale dimensions, the electronic confinement induces original size-dependent properties. For the last decade, the size reduction of graphene was mostly done through conventional top-down approaches to fabricate graphene quantum dots (GQDs)¹ or graphene nanoribbons (GNRs)². However, top-down approaches do not allow a sufficient control of the morphology and oxidation state of the edges, which drastically impact the properties. In order to truly control, with the required level of precision, the morphology and the composition of the materials and of its edges, the bottom-up approach is the relevant way to proceed^{3,4}.

With the aim to study and understand the optical properties of GQD materials, we performed the bottom-up synthesis⁵ of different families of nanoparticles exhibiting controlled shapes and edges. Because of their strong aromatic character graphene nanoparticles tend to aggregate in solution; however, for future application it is of high interest to be able to discriminate the intrinsic absorption and emission of the GQDs from those of aggregates. For example, we observed that by STM and polarized microscopy the GQDs bearing alkyl chains are forming columnar structures with liquid crystal properties in solvents. Here, we study the optical properties of graphene quantum dots as a function of their individualization. Using absorption, steady-state and time-resolved photoluminescence and photoluminescence excitation (PLE) spectroscopy, we try to establish the intrinsic optical properties of the GQDs and understand how the structure influences the properties.

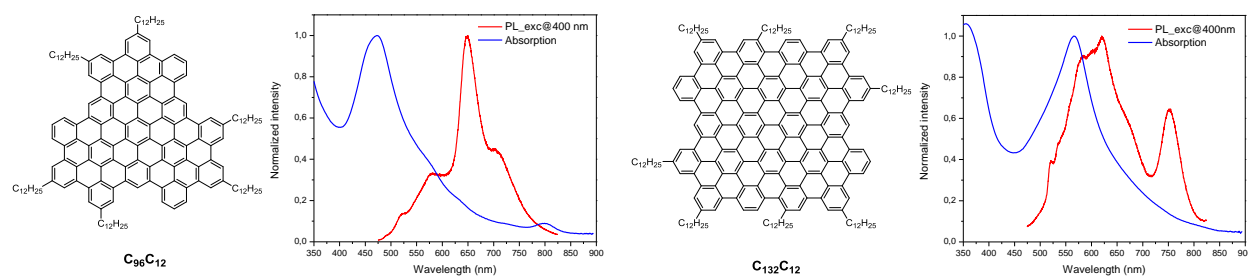


Figure : Molecular Structures of GQDs and their absorption and photoluminescence spectra

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