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Abstract:
Despite its outstanding electronic, optical and mechanical properties, the use of graphene for real-world applications is severely limited because of its semi-metallic character. 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, a great attention has been paid to the size reduction of graphene using conventional "top-down" approaches (lithography and etching, thermal treatments and oxidation of bulk materials) to fabricate graphene quantum dots (GQDs)[1] or graphene nanoribbons (GNRs).[2] However, the "top-down" approaches do not allow a sufficient control of the structure of the material and of the oxidation state of the edges, which drastically affect 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]
Here, I'll present the "bottom-up" synthesis of graphene quantum dots and the first investigation of the photoluminescence (PL) properties of at the single molecular-scale. The GQDs exhibited emission of single photons at room temperature with high brightness and purity.[5-7] Beyond this first demonstration, our interest deals with the study of the structure-property relationship in GQDs and how the size, the symmetry of the particles will permit to tune the emission properties and finally be able to perform reverse engineering to design GQD with tailor-made properties.

References:
[1] Bacon, M.; Bradley, S. J.; Nann, T. *Part. Part. Syst. Charact.* **2014**, *31*, 415-428.
[2] Xu, W.; Lee, T.-W. *Mater. Horiz.* **2016**, *3*, 186-207.
[3] Wu, J.; Pisula, W.; Müllen, K. *Chem. Rev.* **2007**, *107*, 718-747.
[4] Narita, A.; Wang, X. Y.; Feng, X.; Müllen, K. *Chem. Soc. Rev.* **2015**, *44*, 6616-6643.
[5] Zhao, S.; Lavie, J.; Rondin, L.; Orcin-Chaix, L.; Diederichs, C.; Roussignol, P.; Chassagneux, Y.; Voisin, C.; Müllen, K.; Narita, A.; Campidelli, S.; Lauret, J.-S. *Nat. Commun.* **2018**, *9*, 3470.
[6] Liu, T.; Tonnelé, C.; Zhao, S.; Rondin, L.; Elias, C.; Medina-Lopez, D.; Okuno, H.; Narita, A.; Chassagneux, Y.; Voisin, C.; Campidelli, S.; Beljonne, D.; Lauret, J.-S. *Nanoscale* **2022**, *14*, 3826-3833.
[7] Liu, T.; Carles, B.; Elias, C.; Tonnelé, C.; Medina-Lopez, D.; Narita, A.; Chassagneux, Y.; Voisin, C.; Beljonne, D.; Campidelli, S.; Rondin, L.; Lauret, J.-S. *J. Chem. Phys.* **2022**, *156*, 104302.