Emitting Graphene-Based Platforms by Surface-Confined Supramolecular Self-Assembly

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Graphene has potential photonic applications in optical modulators, photodetectors, light harvesting or emitting devices. However, its zero-bandgap electronic structure limits graphene role to transparent electrode. This is why graphene needs to be combined with a complementary photonic material to create a hybrid component with novel properties for advanced photonics.
In this context, the supramolecular self-assembly of organic building blocks on graphene is an original bottom-up approach towards novel materials displaying unusual properties.[1] Hence, the possible fine-tuning of inter-constituents distances and orientations offered by the design of the building blocks makes the self-assembly approach very appealing for adjusting graphene photonic properties.
Here, we present two examples of strategies we have recently developed.
In the first one, graphene and an emitting 3D building block are combined to obtain a light emitting graphene-based hybrid 2D system. We report the first fluorescent molecular self-assembly on graphene [2]. The quenching of the fluorescence of the adsorbed dye by the adjacent graphene is hindered at the molecular scale based on a spacer approach, through a specifically designed dual-functionalized self-assembling building block.
The second example is based on surface-confined host–guest chemistry used to trap a functional 3D building blocks into a large 2D nanoporous template on graphene [3]. This noncovalent graphene functionalization approach allows the immobilization, in a well-defined 2D nanoporous network, of a functional 3D ZnPc complex that projects a dye-based ligand away from the surface and aligned along the normal direction. Thanks to this strategy of decoupling from the graphene as well as the orientation and intermolecular distance control, the platform emits light with the same characteristics as in dilute solution [4].

References

[1] L. Sosa-Vargas, E. Kim, A. J. Attias, *Mater. Horiz.*, 4, 570 (2017).
[2] S. Le Liepvre, P. Du, D. Kreher, F. Mathevet, A. J. Attias, C. Fiorini-Debuisschert, L. Douillard, F. Charra, *ACS Photonics*, 3, 2291–2296 (2016).
[3] R. Brisse, D. Guianvarc'h, C. Mansuy, S. Sagan, D. Kreher, L. Sosa-Vargas, L. Hamitouche, V. Humblot, I. Arfaoui, V. Labet, C. Paris, C. Petit, A. J. Attias, *Chem. Commun.*, 54, 10068 (2018).
[4] B. Kim, E. Kim, I. Arfaoui, C. Paris, C. Petit, A. J. Attias, Under Review (2020)