OPERA: Nanographene for quantum technologies

Main area: Graphene and related materials (GRMs) for Quantum Technologies
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Abstract

The OPERA project aims at mastering the synthesis, the studies and the theoretical understanding of nanoscale graphene (nanographene) materials with perfectly defined structures and on-demand designed properties. The nanographene materials developed in OPERA will be studied in a series of quantum optics experiments in the view to evaluate their potential interest for quantum devices. To do so, OPERA gather partners with complementary skills: chemical synthesis, theory/modelling, spectroscopy, and quantum optics.

Over the last years, significant progress has been made on the development of nanographene materials with perfectly defined structures. This approach comes complementary to the important research efforts devoted to the 2D related materials beyond graphene that aimed at overcoming the limitation enforced by the semi-metal nature of graphene. Such research efforts are driven by the opportunity to obtain graphene-like materials with a sizeable band gap as well as to develop well controlled single quantum objects, i.e. single photons sources.

In this framework, the opportunity to finely tune and control the structure of nanographene by bottom-up chemistry is an important asset over the other approaches (i.e. top-down). This is indeed a key point if one wants to build a reliable structure-properties relationship. In a long term vision, the ability of choosing and controlling the shape of graphene quantum dots can be used as a toolbox for quantum technologies. The possibility to organize them deterministically, and to create artificial quantum dot molecules, will then serve to implement quantum bits and gates.

The OPERA project aims at defining a quantum chemistry engineering route using graphene quantum dots with atomically precise structure:

Definition of the needed functionalities
i.e optical/electrical/magnetic properties, such as optically addressable spin for instance
|
Design and synthesis of the required graphene quantum dot structure
|
Study and use of the graphene quantum dot for quantum technologies

In this context, the objectives of this project are: i) synthesis of new graphene quantum dots exhibiting controlled shapes, edges (zig-zag or armchair) and properties, using the bottom-up approach; ii) evaluation of their optical properties through a combination of advanced experimental and theoretical studies; iii) integration of graphene quantum dot in cavity quantum electrodynamics (CQED) experiments.

Consortium

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