Update work plan

Project Title: "Single Photons *On Demand* from a 2D Material Heterostructure"

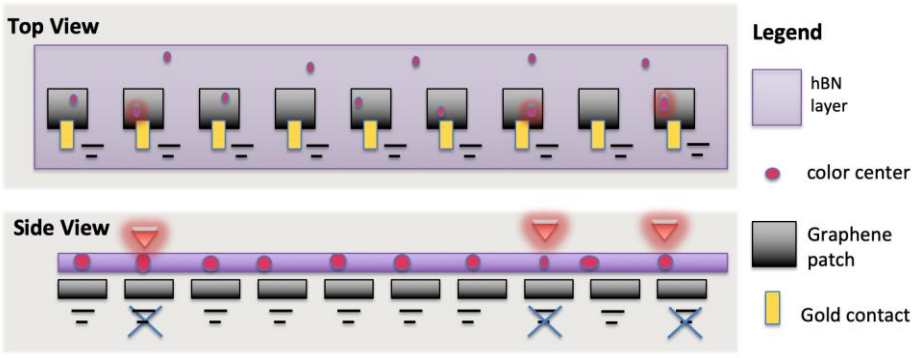
We use M# to indicate month number # counting from the start of the PhD, to set the timeframes for the 4 tasks that constitute the thesis work plan. We also list milestones and deliverables.

Task 1- CVD growth, structural and optical characterization of 2D materials (From M0 to M12)

- Graphene and hBN growth by CVD on Cu catalyst high-purity foils and transferred onto the final substrates (glass and oxidized Si wafers) using a PMMA temporary substrate.
- The quality (defects, number of layers) of the 2D materials will be accessed by Raman spectroscopy and Atomic force microscopy measurements.
- Optical characterization of the impurity centers in hBN will be carried out on the single defects to demonstrate single photon emission via high sensitivity time resolved widefield microscopy and time correlated single photon counting measurements.

Task 2- Fabrication of the Quantum emitter array (From M12 to M30)

- Use standard clean-room nanofabrication technology (EBL, RIE, IM, etc.) to fabricate a device for the electrostatic tuning of the properties of graphene patches, over which a dielectric spacer (~10 nm) and a layer of hBN containing single photon emitters will be placed.
- The fluorescence of the hBN in the device will be characterized in function of the electrostatic field applied to the underlying graphene layer.



Scheme of the single-photon-on-demand-device.

Task 3- Fabricating and testing a Quantum emitter array (From M30 to M40)

- Adaptation of the micro-fabrication process to the nano-scale;
- Design of an electrical connections scheme to actuate an array of devices;
- If necessary, induce further SPE density for reliable presence of at least 1 SPE in the hetero-structure areas;
- Inter-connect distance tests to address possible interference between electric lines;
- Test device switching speeds for future imaging application;

Task 4- Application of the quantum emitter array (From M40 to M45)

- Implementation of the nano-arrays in an early super-resolution fluorescence imaging application by performing selective excitation of fluorophores staining the surface of a test sample;

We set milestones and deliverables whose completion is to happen before their respective month (M#) into the PhD. We adjusted the completion of these milestones and deliveries based on what was accomplished so far and our estimation for the future tasks.

-**Milestones:**

- **Milestone 1**: Successful observation of single photon emission and radiation quenching by graphene (M8).
- **Milestone 2**: Successful fabrication of an electrically controlled single photon emitter (M30).
- **Milestone 3**: Successful fabrication of an array of individually addressed and electrically controlled single photon emitters (M40).
- **Milestone 4**: Successful implementation of the array as a tool for sub diffraction limit fluorescence imaging (M45).

-**Deliverables**:

- **Deliverable 1**: Reports on material characterization of hBN and graphene (M8).
- **Deliverable 2**: report on density of defects per HBN unit area (M12).
- **Deliverable 3**: single photon emitter device (M30).

- **Deliverable 4**: reports of device performance and characterization (M32).
- **Deliverable 5**: array of single photon emitting devices (M40).
- **Deliverable 6**: reports on the characterization of the final device and its initial application results (M45).
- **Deliverable 7**: Doctoral Dissertation to be handed in frame of the MAP-Fis Joint Doctoral Program (M48).

Tiago Alves Queirós
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