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## **Master in Photonics – “PHOTONICS BCN” ERASMUS+ “EUROPHOTONICS”**

### **MASTER THESIS PROPOSAL**

**Dates: April - September 2020**

**Laboratory : Quantum Nano-optoelectronics (Koppens group)**

**Institution: ICFO**

**City, Country : Castelldefels**

**Title of the master thesis: Hyperfocusing infrared light on a graphene pn junction for sensitive photodetection**

**Name of the master thesis supervisor: Frank Koppens**

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Website: [koppensgroup.icfo.eu](http://koppensgroup.icfo.eu)

**Keywords : subwavelength light, photodetection**

**Summary of the subject (maximum 1 page) :**

Graphene based photodetectors have been proposed as an alternative of current technologies due to its broad band absorption properties ranging from visible to terahertz range, low electronic heat capacity and its hot electron cooling time in the picosecond timescale [1], which enables graphene as an interesting platform for ultrafast photodetection. In this work, propose to combine graphene pn junctions photodetectors [2, 3] with metallic nanostructures that serve as launchers-guiders for hyperbolic phonon polaritons to achieve hyperfocusing of the incident mid-infrared light and to boost light-matter interactions. We will use 2D materials that present long lifetimes polaritons, such as hBN and MoO<sub>3</sub> [4].

The goal of the thesis is to develop a novel platform for infrared photodetection for exploring fundamental and applications aspects that can be used in a wide range of areas (molecular sensing, optical communications, etc.). The photodetectors will be characterized by optical techniques including scanning near-field optical microscopy (s-SNOM). The student will be able to use current state-of-art tools for nanofabrication of the photodetectors, Van der Waals heterostructure assembly of two-dimensional materials and to perform opto-electronic measurements in the mid-infrared (mid-IR) range. The student will take advantage of previous work performed by the group in this field [2, 3, 4].



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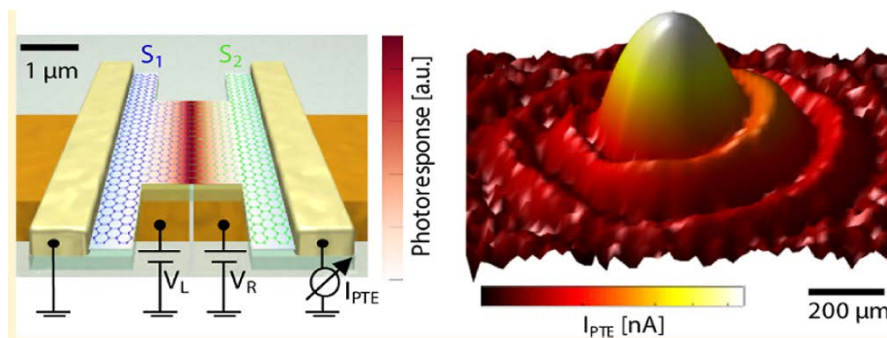


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## References:

- [1] Koppens et al. *Nature Nano.* **9**, 780-793 (2014)
- [2] Castilla et al. *Nano Lett.* **19**, 5, 2765-2773 (2019)
- [3] Castilla et al. *In preparation* (2019)
- [4] Woessner et al. *npj 2D Mater Appl* **1**, 25 (2017)



## Additional information :

\* Required skills : Physics and/or optics studies

\* Miscellaneous : The project will be carried out in the group of Prof. Frank Koppens at ICFO. This group has all the state-of-the-art facilities on 2D material research and technology development, including photoluminescence setups at low temperature and near-field scanning optical microscopes. The work led to more than 80 articles on this topic that have received over 20.000 citations. See:

[koppensgroup.icfo.eu](http://koppensgroup.icfo.eu)

and

[graphene.icfo.eu](http://graphene.icfo.eu)