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Post-doctoral position at Institut Langevin (ESPCI) in Paris

Nanoscale study of infrared emission from van der Waals heterostructures and plasmonic antennas.

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In a paper recently published in NATURE, our team in collaboration with a consortium led by Emmanuel Baudin at LPENS has demonstrated that graphene-based transistors encapsulated in boron nitride (hBN) are electroluminescent in the mid-infrared [Abou-Hamdan_NATURE2025]**.** This exotic source of light from a van der Waals heterostructure was investigated so far by ultra-sensitive infrared microscopy combined with Fourier transform infrared spectroscopy (FTIR) [Li_PRL2018; Abou-Hamdan_ACSPhot2022].

We hire a motivated experimentalist to extend our knowledge of graphene electroluminescence by carrying out infrared near-field scanning optical microscopy measurements on graphene-based devices in operation. We will use for these studies a TRSTM (thermal radiation scanning tunnelling microscope) developed by our team. Similar to a SNOM, this unique instrument uses a tungsten tip as subwavelength-sized scanning antenna to image near-field infrared radiation emitted by the sample itself, rather than using external illumination [DeWilde_NATURE2006]. The TRSTM will also be used to perform super-resolved FTIR spectroscopy on graphene devices in operation, similarly to our previous investigations of non-Planckian near-field thermal radiation [Babuty_PRL2013].

The second objective of this postdoc is to use intense laser illumination to excite thermally some specific electromagnetic modes of infrared plasmonic nano-antennas [Langevin_PRL2024] **to produce optically programmable infrared sources.** Such optically programmable devices produced in collaboration with Patrick Bouchon's group at ONERA could be of use in the future for free space infrared telecommunications.

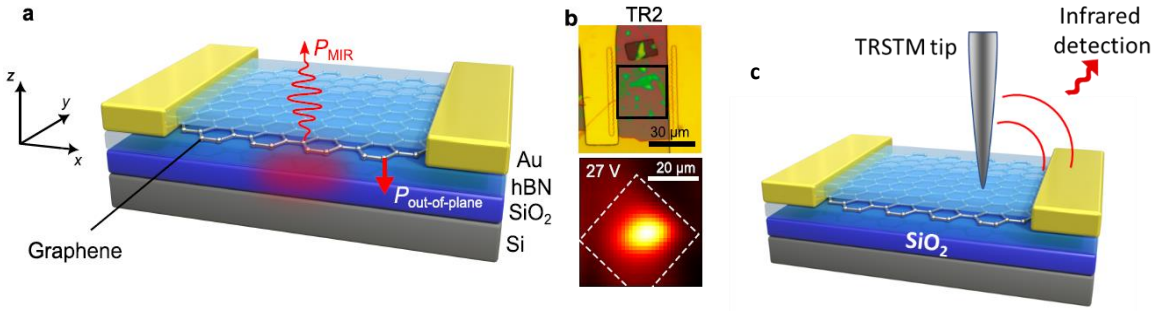

Figure: *(a) Electroluminescent infrared transistor based on a graphene sheet encapsulated in hBN ; (b) Optical microscopy image of the device and far-field mapping of the mid-infrared electroluminescent signal ; (c) TRSTM measurements to be developed during the post-doc to obtain super-resolved images and spectra of the near-field infrared electroluminescence from the devices in operation.*

This post-doctorate is part of the ELuSeM project funded by the French National Research Agency. The post-doc will be carried out at Institut Langevin in Paris (Yannick De Wilde's team) in collaboration with the Physics Laboratory of the Ecole Normale Supérieure (LPENS), the Laboratoire Charles Fabry-IOGS, the ONERA, …

REFERENCES:

[Abou-Hamdan_NATURE2025] L. Abou-Hamdan et al., *NATURE 639, 909–914 (2025)*.
[Li_PRL2018] C. Li et al. , *Phys. Rev. Lett.* **121**, 243901 (2018).
[Abou-Hamdan_ACSPhot2022] L. Abou-Hamdan et al., *ACS Photonics* **9**, 7, 2295–2303 (2022).
[DeWilde_NATURE2006] Y. De Wilde et al., *Nature* **444**, 740–743 (2006).
[Babuty_PRL2013] A. Babuty et al., *Phys. Rev. Lett.* **110**, 146103 (2013).
[Langevin_PRL2024] D. Langevin et al., *Phys. Rev. Lett.* **132**, 043801 (2024).

ACTIVITIES:

Main tasks in experimental physics:
- Ultra-sensitive infrared measurements on active van der Waals heterostructures
- TRSTM; SNOM
- FTIR spectroscopy; IR SMS (spatially-modulated infrared spectroscopy)
- Setting up laser heating of plasmonic antennas on measurement bench
- Electromagnetic modeling

Secondary tasks:
- Design of plasmonic antenna samples for lithography
- Contribution to other experimental studies

Required skills:

- Experimental physics
- Optics; Nano-optics
- Scanning probe microscopy: Mastery of near-field microscopy techniques.
  Desirable experience: infrared SNOM and FTIR (nano)spectroscopy; scanning probes with RHK control electronics, ...
- FTIR spectroscopy; infrared nano-spectroscopy
- Electromagnetic modeling (COMSOL, LUMERCIAL, RETICOLO, MAN, SCUFF EM, ...)

Host laboratory and team:

Located in the heart of Paris, the Institut Langevin is a world-renowned research unit of ESPCI Paris, PSL University and CNRS, dedicated to wave physics and its applications. The spectrum of waves involved is very broad: mechanical waves (acoustic, elastic and seismic waves, waves), electromagnetic waves (radiofrequencies, microwaves, Terahertz) and optical waves (infrared and visible).

Dr. Yannick De Wilde is both Director of the Institut Langevin and head of a team of experimental physicists whose activities are mainly focused on nano-optics and plasmonics in the infrared, micro- and nano-thermics, near-field microscopies, super-resolved imaging and spectroscopy,... Valentina Krachmalnicoff, an expert in super-resolved fluorescence for nanophotonics studies, is the second permanent researcher on the team.

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