INTERNSHIP PROPOSAL

Laboratory name: INSP - Sorbonne Université
CNRS identification code: UMR 7588
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Internship location: Sorbonne Université campus Jussieu, 4 place Jussieu, 75005 Paris

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ANR (already secured)

Operando investigation of optoelectronic device using advanced photoemission

Scientific description: Beyond traditional semiconductor grown by epitaxy, there is a vast range of emerging materials, including quantum dots, 2D materials, and quantum and topological materials. However, the integration of such materials into devices requires a deep understanding of their electronic structure. The basic hypothesis so far relies on measuring pristine materials properties and hope that these properties will remain mostly unchanged once the material is integrated into a device. While this assumption is certainly sufficient for first generation of devices, it is clearly insufficient for achieving higher performance levels. Thus, new method enabling operando investigations (where measurements are performed while the device is in operation) are required. Our team at INSP has developed a new platform that combines a wide range of capabilities, spanning from a few meV to 5 keV, by combining Raman, infrared, and visible spectroscopy with multi source X ray photoemission (XPS). This setup also allows for control of temperature and bias application, enabling us to explore material properties that were previously inaccessible. A paramount example is the investigation of nanocrystal-based LED. This device has a vertical geometry that is typically incompatible with the low escape depth of standard laboratory photo electron spectroscopy. However, the unique hard X-ray capacity of our setup combined with update of device design using 2D materials, will enable to probe the active layer under operando conditions.
Additionally, supplementary measurements conducted at synchrotron facilities, to gain higher photon flux or spatial resolution, will complement this study during the PhD phase of the project.
Techniques/methods in use: clean room, XPS measurements both in the lab and at synchrotron, Raman spectroscopy, optoelectronic device characterization.
Applicant skills: a solid background in semiconductor physic is essential. The project is highly multidisciplinary spanning chemistry, physics and engineering. Additional background including photoemission, 2D material, nanocrystals, device fabrication would be a plus.
Applicants must speak English

References:

1. Khalili, A. *et al.* ACS Appl. Electron. Mater. (2023)
2. Cavallo, M. *et al*. Nano Lett. 23, 1363–1370 (2023)
3. Cavallo, M. *et al.* Adv. Funct. Mater. 33, 2300846 (2023)
4. Cavallo, M. *et al.* Nanoscale 15, 9440–9448 (2023)
5. Cavallo, M. *et al*. Nano Res. 1–10 (2024)

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO