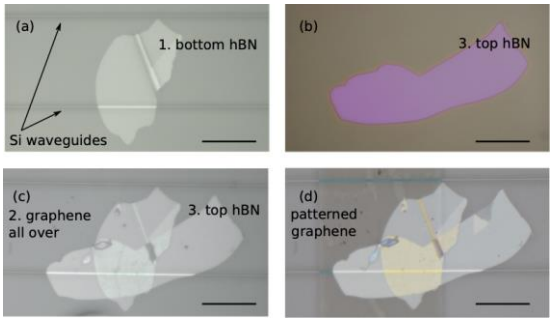
PhD thesis subject for CSC scholarship 2023

Title	Integrated nanophotonic devices with 2D materials
Doctoral School	Doctoral School 361 "Sciences for the engineer"
Supervisor	Rafael Salas-Montiel
Research Unit	L2n CNRS EMR 7004 & UTT
Keywords	2D materials, integrated photonics, near field scanning optical microscopy, nanofabrication (EBL)
Abstract	Two-dimensional (2D) materials integrated with photonic devices has emerged as a research field for the development of a novel 2D material integrated circuit technology. Several integrated devices have been shown such electro-optical modulators and photodetectors. Van der Waals heterostructures, a stack of 2D materials, are heterostructures that have shown advantages in terms of device performance thanks to the electrical and optical properties of 2D materials such hexagonal boron nitride (hBN) and graphene. Furthermore, the development of polymer based dry transfer methods provides a straightforward way to integrate 2D material on integrated photonic devices.  **Fig. 1**. Van der Waals heterostructure on silicon waveguide. Specifically, hBN-graphene-hBN on a silicon photonic waveguide. However, the intrinsic electrical and optical properties such as dielectric screening by 2D materials have been rarely investigated and still is an important fundamental research field. In this doctoral project, we aim at investigating the electrical and optical properties of 2D materials integrated on silicon photonic devices with the use of near field scanning optical microscopy (NSOM). NSOM measurements will provide a direct method for probing the electronic and optical properties of 2D materials.

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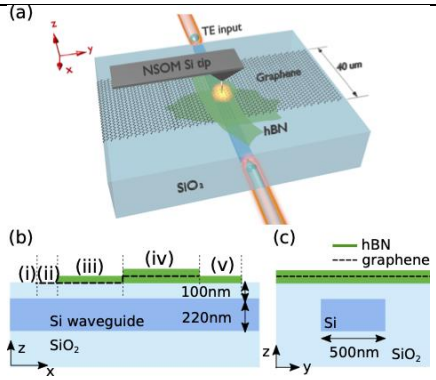

Fig. 2. Scheme of the NSOM characterization of vdW heterostructure on silicon photonic waveguide.

Also, the goal is to optimize and characterize integrated photonic devices with 2D materials.

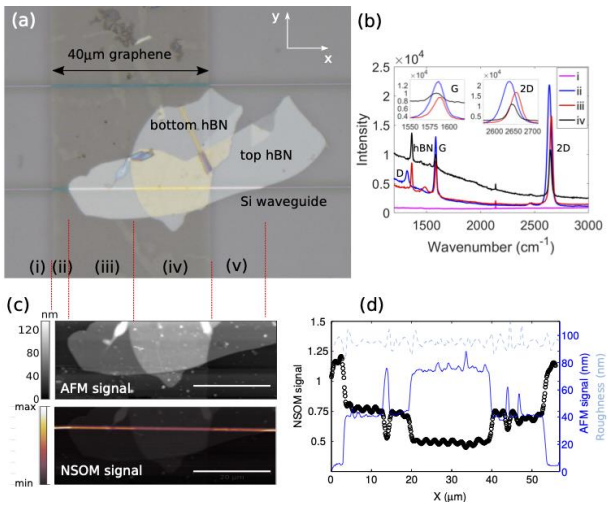

Fig. 3. Raman and NSOM characterization of the vdW heterostructure on silicon photonic waveguide.

The PhD student will be involved in theoretical analysis, electromagnetic modeling: Finite Difference Time Domain (FDTD) method, Finite Element Method (FEM), and mode solvers, as well in the fabrication with electron beam lithography (EBL) and reactive ion etching (RIE) processes in cleanroom environment as well as the characterization of the integrated devices.
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<td>Candidate profile</td>
<td>Master's degree in physics, engineering, nanotechnology, or a related area. Basic experience on numerical simulation (FDTD, Mode Expansion) and experimental photonics. Experience in a cleanroom environment is expected, but not required. Fluent in English.</td>
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