International Doctoral Program in Science Position

2D transition metal dichalcogenides: CVD synthesis, electrical and optical characterization

Background and motivation

2D transition metal dichalcogenides (TMDs) hold great potential for application in different fields, in particular in nanoelectronics and photonics. In nanoelectronics, large energy dissipation due to heating in chips is unsustainable in terms of both costs and performance drop and 2D TMDs hold great potential to alleviate these problems. In photonics, the integration of 2D TMDs is predicted to enhance the energy harvesting. Towards such applications, it is crucial to develop a controlled, engineered, synthesis at large scale of such materials with high uniformity and to investigate their electronic/optical/thermal dynamics. Among the TMDs, MoS2 and MoTe2 are the most attractive materials to be investigated.

In this context our research project targets 2 main goals and some key aspects as follows:

1) Establish standard growth protocols for the chemical vapor deposition (CVD) synthesis of 2D TMDs at large scale on bulk flat and ad-hoc patterned substrates (i.e. SiO2/Si, Si3N4/Si).

1.1 develop a scheme of a fabrication compatible with a process transferrable to the wafer scale;

1.2 study the electrical and optical response of such structures in proto-devices (internal photoemission, electron transport, absorbance, photoluminescence, photoconductivity).

1.3 explore transfer methods as key enabling technology for TMD integration to Si CMOS platform.

2) Develop time-resolved high resolution optical microscopy methods to investigate the electronic and thermo-mechanical aspects of 2D TMDs deposited on a bulk substrate.

2.1 fast optical surface mapping in various environments (i.e. air and liquids) by microsphere assisted optical microscopy to get sensitivity to the few atomic layers constituting the surface termination;

2.2 thermo-mechanical characteristics of the film-substrate adhesion and its uniformity (by optical techniques and dynamic AFM);

2.3 investigation of the electronic and thermo-mechanical response of patterned surfaces.

Profile

- Master's degree or comparable qualification in Physics, Materials Science, Materials Engineering, Electronic Engineering or adjacent fields. The title must be obtained by October 31st, 2020.
- Candidates should have a solid background in optics and/or materials science, and a strong interest for multidisciplinary research.
- experience in the growth of 2D transition metal dichalcogenides by chemical vapor deposition and their characterization using Raman spectroscopy, scanning electron microscopy and electrical methods (C-V, I-V, Internal photoemission) and/or in microscopy and/or ultrafast optics will be considered as an additional advantage.
- Good knowledge of the English language, both spoken and written, is essential.
- Strong commitment, ability to work in a team, and eager for international mobility are desired.

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Opportunities

- Participating to an international collaboration among Università Cattolica del Sacro Cuore, Institute of Microelectronics and Microsystems (IMM-CNR) and KU-Leuven (Belgium).
- **Double degree opportunity.**

Contacts

Prof. Gabriele Ferrini, UCSC gabriele.ferrini@unicatt.it
Dr. Alessio Lamperti, IMM-CNR alessio.lamperti@mdm.imm.cnr.it
Prof. Valeri Afanasiev, KU-Leuven valeri.afanasiev@keuleuven.be
Prof. Christ Glorieux, KU Leuven christ.glorieux@kuleuven.be