International Doctoral Program in Science Position

Investigation of few-atoms-thick films by time-resolved high resolution optical microscopy

Background and motivation

Thin films science and technology plays an important role in the high-tech industry. The quest for development of smaller and smaller devices requires advanced materials and new processing techniques. Thus, determination of the nature, functions and new properties of thin films can be used to develop new technologies for future applications. The aim of this project is to use high resolution optical imaging techniques to provide a new probe to characterize and measure the physical and optical properties of few-atoms-thick films.

Recently, an optical microscope with imaging capabilities beyond the diffraction limit has been demonstrated. The microscope provides a sub-100-nm-resolution with visible light illumination using the light focusing properties of transparent microspheres. This microsphere assisted super-resolution optical imaging enhances the spatial resolution of traditional optical systems, allowing to image sub-wavelength structures. The microscope will provide static white-light maps related to the thickness and uniformity of two-dimensional samples in the form of mono-elemental (Si, Sn) and dichalcogenides (Mo,W)Te thin films nanosheets. Since super-resolution exploit the evanescent waves present on the sample surface, a high sensitivity to thickness inhomogeneity is expected. The microscope will be merged with a time-resolved reflectivity/transmissivity apparatus, implemented through the ASynchronous OPtical Sampling (ASOPS) technique. ASOPS allows high-speed pump-probe scanning over a nanosecond time window without a delay line. This set-up will generate transient reflectivity/transmissivity maps with 100 nm lateral resolution. The degree of adhesion of the thin films to the substrate, their thermomechanics and spatial uniformity will be investigated and characterized using principles from picosecond acoustics. Novel dynamic Atomic Force Microscopy (AFM) techniques will complement the nanoscale investigation of the thin films.

Finally, it will be important to develop models for the data interpretation, also in view of the great deal of spectroscopic information that is potentially available in each pixel of an image. In this respect, automated analysis techniques will be considered.

Profile

- Diploma: Master's degree or comparable qualification in Physics, Materials Science, Chemistry or adjacent fields. The title must be obtained before OCTOBER 31ST 2019.
- Candidates should have a solid background in optics.
- A strong interest for multidisciplinary research is required.
- Previous experience in microscopy and/or ultrafast optics will be an asset.
- Good knowledge of the English language, both spoken and written, is essential.
- Strong commitment, and eagerness for international mobility is desired.

Opportunities

- Participating to an international collaboration between UCSC (Italy) and KU (Belgium)
- Double degree opportunity.
- This position is supported by a fellowship of 15.343 (gross income) per year. The monthly allowance is increased by 50% when students are abroad.

Supervisors

- Prof. Gabriele Ferrini, UCSC gabriele.ferrini@unicatt.it
- Dr. Eduard Fron, KU Leuven