PhD Scholarship in materials science, physics of semiconductors and opto-electronic devices, physical-chemistry, and engineering

Code Moyens-RH: **FR5-ADR2-PV**

Title: Architectured & Flexible Structure for Building Integrated Photovoltaics

Laboratories and researchers:
LMGP http://www.lmgp.grenoble-inp.fr/: D. Muñoz-Rojas, C. Jiménez, J-L. Deschanvres, D. Bellet
SIMAP http://neel.cnrs.fr/: G. Chichignoud, A. Mantoux, L. Latu-Romain
IMEP-LaHC http://imep-lahc.grenoble-inp.fr/: A. Kaminski, D. Bucci, Q. Rafhay

Doctoral School: **I-MEP2**

Context of the PhD grant:

The PhD grant is associated with the IDEX (Institute of Excellence) at Grenoble and more specifically linked with the Cross Disciplinary Program Eco-SESA: "Eco-district: Safe, Efficient, Sustainable and Accessible energy". Based on observations at the building and neighbourhood levels, the Eco-SESA project aims to produce knowledge, concepts, tools and methods to rethink the planning, management and governance of urban energy systems and the design of their components. With a view to a safe, efficient, sustainable and accessible energy, these contributions will be shared with the scientific communities and the city and energy stakeholders. The Eco-SESA project will contribute to better taking into account the societal challenges of the energy transition, to extend the reputation of the Grenoble site to the social and human sciences, to increase the capacity to develop deployable innovations and, in so doing, to strengthen the international influence of the site. The integrated system approach is organized around 5 emerging research fronts to the convergence of scientific communities working on energy. Interdisciplinarity for instance between Material Sciences and Social & Human Sciences will be an important point in Eco-SESA since such interdisciplinarity will generate innovations. Therefore candidates will be selected with the following criteria: i/ excellence, ii/ strong motivation, iii/ appropriateness of candidate's competences with the proposed PhD project and iv/ the capacity of the candidate to work as well with other disciplines (than materials science) and to work in a cross-disciplinary context.
Grenoble is the second French research and innovation site after Paris and comes out as the best place in France to study.

Problematic & Context:

Despite the fact that the amount of solar energy reaching the Earth in just two hours would be enough to cover human energy demands for one year, solar photovoltaic still represents less than 3% of the current renewable energy share, and it is far from being a real alternative to fossil fuels. One of the reasons is that the cost efficiency ratio of current solar cell technologies is not attractive enough if compared with the price of energy generated from fossil fuels. Solar energy also presents the issue of being an intermittent energy source and thus efficient, reliable and eco-friendly energy storage solutions are to be developed. Another important factor limiting the market penetration of photovoltaics is linked to aesthetics and integration. Nowadays solar cells based on Si are the most current in the market. Those cells are assembled in panels that are dark, flat and heavy. This has an impact on their attractiveness since many potential customers find that Si do not look nice on their roofs. Flat cells are at the same time not well adapted to more complex or curved surfaces. Finally, the weight of current panels requires the use of sturdy structures that contribute to the price of this technology.

In this context, the development of eco-friendly, low-cost, and efficient solar cells being light-weight and adaptable to different surfaces and architectural spaces is essential and will be the framework of the present PhD thesis. The thesis will focus on the development of novel building integrated (indoor and outdoor) photovoltaic cells (BIPV). These cells will present several key features: conversion efficiency under sun and artificial light, flexible or with predefined shapes, low-cost and tailored/customized front face color. The cells will be composed of abundant and non-toxic elements, and will be produced through low-cost wet chemical techniques. To tackle these ambitious objectives the thesis will greatly benefit from already established results from previous projects.

Main objectives and proposed work during the Thesis:

The main objectives of this PhD thesis will be to optimize the deposition of thin film photovoltaic cells for indoor and outdoor applications, including non-flat surfaces. To this aim, the PhD student will work on the strongly correlated main three aspects: i) selection of materials ii) the modelling of the proposed devices, iii) the optimization of material deposition and processing steps, and IV) device characterization. Direct relationships will be established with Social & Human Sciences to estimate how the characteristics of the proposed cells (colour, weight, flexibility, cost, materials, technology, recycling issue…) can affect the potential of the PV market, for instance by changing the consumption habits.

Proposed methods during the Thesis:

In the whole work of the present thesis, the PhD student will use different vapour chemical deposition techniques (Chemical Vapour Deposition, (Spatial) Atomic Layer Deposition, and several characterization techniques such as electron microscopy (SEM, TEM, STEM), X-ray diffraction, thermal and chemical analyses, UV-Vis-NIR spectrophotometry, optical spectroscopy (photoluminescence, cathodoluminescence, thermoluminescence, electroluminescence, Raman spectroscopy…), Hall effect measurements (4 points). As metallic substrates will be implemented to ensure the flexibility of the structure, additional characterizations are necessary to highlight defects potentially generated by the association of different materials or during the bending. The performance of the solar cells will be evaluated by IVT and quantum efficiency measurements. Optical and electrical simulations will be performed with home-made and commercial softwares (Sentaurus, Silvaco…).

Keywords: photovoltaics, materials stability, interface reactivity, Chemical Vapor Deposition, (Spatial) Atomic Layer Deposition, Transparent conductive materials, optical and electrical simulation

Collaborations & international opportunities:

The PhD student will take part in the deposition of the oxide-based solar cells on different substrates and on the modelling of the cell stacks. Additional international collaborations may be established with Konstanz University and University of Catania.

Scientific environment: Located in the heart of an exceptional scientific environment, LMGP, SIMAP and IMEP-LaHC offer the applicant a rewarding place to work. Moreover, the applicant will be integrated within a close collaboration between several scientists of LMGP, Institut Néel, IMEP-LaHC, and CEA laboratories as well as of G-SCOP, GAEL, and PACTE.

Profile: We are looking for a highly motivated student with outstanding or excellent Master's degree or equivalent qualification who is interested to work in an inter-disciplinary project. The main scientific cores are: materials science, physics of semiconductors and opto-electronic devices, physical-chemistry, and engineering. Interpersonal skills, dynamism, rigor and teamwork abilities will be appreciated. Candidates can be fluent either in English and/or in French.

Salary: According to French regulations for PhD

Application must be sent before the **1st of June 2017** in English or in French with the following:

- Curriculum vitae
- Cover letter
- Master thesis summary

Starting date for the scholarship: 1st September or October, 2017

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