ED STITS

Thesis subject 2012

Laboratory: Laboratoire de Génie Electrique de Paris (LGEP)
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Title of the thesis :

Engineering of CVD graphene optoelectronic properties
Application as transparent electrode in advanced solar cells designs

Collaboration within the thesis : partnership

	Laboratories		**Institution**
Host	**LGEP** Laboratoire de génie électrique de Paris	UMR 8507	CNRS-SUPELEC-Paris Sud
Part. 1	LPN Laboratoire de photonique et de nanostructures	UPR 20	CNRS
Part. 2	LPICM Laboratoire de physiques des interfaces et des couches minces	UMR 7647	Ecole Polytechnique
Part. 3	LCSI Laboratoires de chimie des surfaces et interfaces	na	CEA

Program affiliation : GraphIC (*Graphene growth Interfaces & Characterization)* supported by Labex Nanosaclay

This subject can be published on the doctoral school's website : Yes

Thesis's summary (Abstract)

Hetero-interfaces between 2D-nanomaterials and semiconductors will undoubtedly shape the future of nanoelectronic devices [1]. With the advent of large scale chemical vapour deposition (CVD) graphene, there is a strong research effort to implement this material into optoelectronic devices. Replacement of Indium Tin oxide (*ITO*) as transparent conductor (*TCF*) is of great interest for optoelectronic devices as well as solar cells [2]. Alternatives such as ZnO (*Zinc oxide*) and Carbon nanotubes (*CNTs*) present physical and electrical limitations [3]. Exfoliated graphene exhibits optoelectronic properties that could potentially outperform any alternative to ITO currently investigated. Nevertheless to envision applications the optoelectronic properties of CVD-Graphene still remain to be tailored to become competitive with ITO. For that purpose, a strong research effort is devoted to develop doping strategies as well as characterization techniques to investigate this new type of nanomaterials [4]. This research project is part of a framework consisting of LGEP, LPN, LPICM and LCSI labs. LPN will undertake the synthesis of CVD graphene and is among the few laboratories in Europe developing this technology. LPICM fabricates organic and inorganic hetero junctions devices [5] whereas LCSI develops chemical doping strategies to modulate the optoelectronic properties[6]. LGEP will carry out the characterization of nanostructures and advanced solar cell designs. In this context, we plan to investigate CVD graphene with the aim of tuning its resistivity and work function in order to qualify this material as a possible alternative to ITO. Objectives are : > 90% transparency in visible and near infrared range, reflection <10% in the same range, resistivity < 100Ω/ □. This work should ideally yield to state of the art organic as well as inorganic solar cell hetero junctions using CVD graphene as transparent electrode fig.1. To achieve this goal, many scientific and technological issues must be overcome *i.e.* the modulation of optoelectronic properties through synthesis and charge transfer using hetero-interfaces. In that respect, characterization plays a key role, the Thin films group at LGEP has been involved for more than 20 years in the development of characterization techniques and modeling of electronic transport in advanced thin films and hetero-interfaces [7]. LGEP holds state of the art characterization methods such as XPS/UPS, AFM, photoluminescence, Raman spectroscopy, four probes station with temperature control as well as innovative techniques dedicated to nanomaterials. Candidates with EEng or Physics master's degree are encouraged to apply and must have the willingness to involve in a strong experimental and multidisciplinary study.

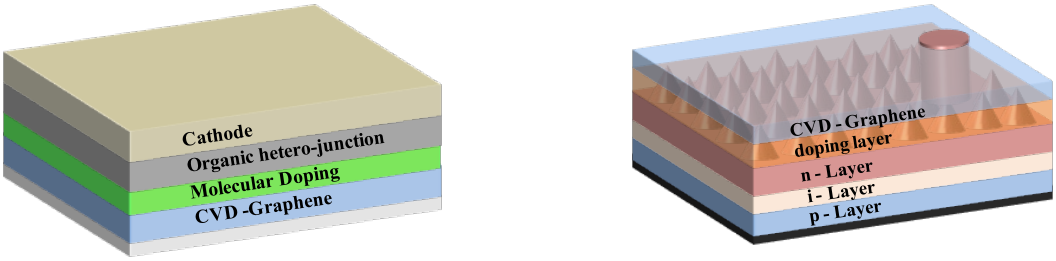

Figure 1: solar cells designs with CVD graphene and doping layers

[1] : Novoselov et al, Science 306(5696): 666–669 (2004)
[2] : Liu et al, ACSNanon, VOL. 6, 1, 810–818 ' (2012)
[3] : Mûller et al, Solar Energy 77, 917–930, (2004)
[4] : Bae et al [Nat Nanotech 5, 574–578 (2010)
[5] : A. Salomon et al, Proc. of the 25th EU-PVSEC, 671 (2010).
[6] : P. Viel et al, J. Mater. Chem., *18*, 5913-5920**.** (2008)
[7] : F. Hauquier et al, Appl. Surf. Sci., 258, 2920–2926, (2012)