Laboratoire de l'Intégration du Matériau au Système CNRS UMR 5218

PHD POSITION:

INTERFACE STABILITY EVALUATION AND OPTIMIZATION FOR ORGANIC PHOTOVOLTAIC DEVICES

SUMMARY:

In the organic photovoltaic field, numerous laboratories are focusing on the first limiting point of the organic PV devices: the low power conversion efficiencies. To solve this issue, lots of efforts are put into the development of low-band gap polymers and optimization of the active layer morphology. However, the second limiting factor, the instability of the devices, is not as investigated. But in the context of building long-lifetime efficient organic solar cells, the understanding of the degradation mechanisms in OPV is as important as the improvement of the devices efficiencies.

In this overall context, the aim of the PhD study is to evaluate the robustness of the different device architectures when submitted to various stresses, to understand the failure of the devices and investigate solutions to improve their robustness. Failures of the devices can origin from various modifications: morphological changes in the active layer, intrinsic degradation of the materials and interfacial degradation. This project focuses on the degradation mechanism at the interfaces. It will be divided in two stages.

The first stage of the project will focus on the evaluation of the robustness of interfaces against various stresses (heat, light, presence of oxygen or moisture…). The stability of different interfacial layers for hole or electron extraction as well as the type of electrode will be studied under different aging conditions. The aim of this first stage is to elucidate the degradation mechanism of the commonly proposed architectures of organic photovoltaic devices. Indeed, understanding the weakest points of the organic solar cells is the first step of the improvement of their lifetime. To achieve this goal, the PhD student will have to build an aging chamber, with in-situ device characterization, in which several atmosphere parameters can be controlled (temperature, light, oxygen content, hygrometry).

After ageing of the devices, the physical and chemical modifications at the interfaces will be studied by different kind of analytical techniques. Auger electrons spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS), coupled with argon etching, will be used to make degradation profiles in order to study diffusion phenomena and chemical modifications at the interfaces. Cross-sectional TEM or SEM will also be used to study the delaminating phenomena. Chemical and physical modifications at the interfaces will be correlated with the modifications detected in the extraction/injection of charges and the changes in the photovoltaic performances. UPS might also be used to analyze the eventual modification in the work functions of the electrodes or the ionizing potential of the organic semi-conductors.

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In a second stage, after having elucidated the interfaces failure mechanisms, solutions to improve the performance stability of the organic solar devices will be investigated. A way to improve the robustness of the bottom interface is to create an intimate contact between the active layer and the hole or electron selective layer. The latter can serve multiple purposes, including alignment of energy levels at interfaces for better charge selectivity and robustness of the interfaces. The idea of this part is to investigate the potentiality in terms of robustness of covalently grafted layer on metal oxides (ITO, electron selective layers or hole selective layers). Such kind of covalently bonded layers should promote the adhesion between the metal oxide and the organic layer and might, in terms, improve the lifetime of the devices.

CANDIDATE'S PROFILE:

For this study, the IMS laboratory expects a chemical physicist or material scientist. Knowledge in the physics of the semi-conductor is mandatory. One or several experiences in the organic electronic field would be appreciated.

STARTING DATE:
The PhD study will start in October 2013.

SALARY:
The founding of the PhD thesis is granted for 3 years: 1685 €/month (gross salary), around 1380 €/month (net salary)

LOCALISATION AND SUPERVISION:

The PhD student will be located in the « Laboratoire de l'Intégration du Matériau au Système (IMS – CNRS UMR 5218) », in Bordeaux, France. He/She will be working in the ELORGA team (http://www.enscbp.fr/ims-elorga/) leaded by Dr. Lionel Hirsch. Collaborations with other laboratories on the campus (LCPO, ISM, ICMCB) will allow the student to access at different kind of characterization techniques for developing his/her project.
The PhD project will be developed under the supervision of Dr. Sylvain Chambon and Dr. Lionel Hirsch (Official supervisor).

APPLICATION:
Applications have to be sent by mail at:

- Dr. Lionel HIRSCH (Research Director at CNRS): lionel.hirsch@ims-bordeaux.fr
- Dr. Sylvain CHAMBON (Researcher at CNRS): sylvain.chambon@ims-bordeaux.fr

The application will include a CV, a motivation letter, a transcript of Master 1 and 2 and a letter of recommendation from two references.