

### MISSION TITLE

## PhD offer (IPVF, Palaiseau/LMGP, Grenoble): Innovative encapsulation of solar cells and modules by Atomic Layer Deposition

### POSITION DESCRIPTION

<b>Function</b>	Doctoral Researcher	<b>Contract type</b>	CDD
<b>Education</b>	Ms in Material Science, Physics, or other relevant fields	<b>Duration</b>	36 months
<b>Working Place</b>	Palaiseau, Paris area (IPVF) / Grenoble (LMGP)	<b>Starting date</b>	From 2023, Sept 1 <sup>st</sup>

### IPVF IN BRIEF

**IPVF** - Institut Photovoltaïque d'Île-de-France, is a global Research, Innovation and Education center, which mission is to **accelerate energy transition through science & technology**. Gathering industrial PV leaders (EDF, TotalEnergies, Air Liquide, Horiba and Riber) and world-renowned academic research organizations (CNRS, Ecole Polytechnique), multi-disciplinary and international IPVF teams conduct research for clean energy technologies. Supported by the French State, IPVF is labelled Institute for Energy Transition (ITE).

*IPVF at a glance:*

- *An ambitious Scientific and Technological Program (6 programs divided in 24 work packages): from tandem solar cell technologies to economy & market assessment, state-of-the art characterization, photocatalysis and breakthrough concepts.*
- *A state-of-the-art technological platform (8,000m<sup>2</sup>): more than 100 cutting-edge equipment's worth €30M, located in cleanrooms (advanced characterization, materials deposition, prototypes for fabrication, modelling...).*
- *A high-standard Education program (M.S. and PhD students). Website: <https://www.ipvf.fr>*

### LMGP IN BRIEF

**LMGP** - The Materials and Physical Engineering Laboratory (LMGP) is a research laboratory in materials science. It is a joint Research Unit (UMR 5628) of CNRS and Grenoble Alpes University (<http://www.lmgp.grenoble-inp.fr>). With 44 Grenoble INP and CNRS permanent staff and about 50 PhD students and post-doc fellows, highly international. It is active in the fields of "crystal growth", "thin films, nanomaterials and nanostructures" and "interactions between materials and biological matter". The LMGP is a member of the CEMAM and MINOS Labex (excellence laboratories), the Micro- and Nanotechnology Federation (FMNT) and of the former Grenoble Nanosciences Foundation. As a member of the Carnot Institute "Energies du futur", it participates in industrial research projects and possesses the ISO STANDARD 9001-2015 certification for its operational organizational structure. Through shared platforms (PTA, CMTC, etc), the LMGP has access to many fabrication and characterization techniques.

### JOB CONTEXT

The nation-wide "Programme et Equipement Prioritaire de Recherche" (PEPR) TASE ("Technologies Avancées des Systèmes Énergétiques") aims to promote the development of a French industry for new energy technologies, for greater independence, creating jobs and capable of meeting current and future global demand of renewable energies and electrification of uses. The National Strategy has identified three priority sectors, including photovoltaics.



The project “**REACTIVE \_ SmaRtEr And eCo innovaTion building blocks for advanced PV ModuLE**” addresses the need for innovative encapsulation technologies to facilitate dismantling and recycling, while maintaining performance and reliability. Indeed, an efficient (module lifetime > 25 years) and low-cost encapsulation solution is needed to enable market entry/deployment of PV technology.

Thin Film Encapsulation by ALD (Atomic Layer Deposition) has proven to be a very efficient way to encapsulate devices such as OLED, but several challenges remain for PV applications (flexibility, temperature dependence, long-time operating conditions, cost, throughput,)

IPVF has developed encapsulation layers based on inorganic layers deposited by ALD, but more water-resistant layers such as inorganic nanolaminates must be prepared and characterized. Also, a major obstacle that hinders the development of efficient encapsulation layers is that the ageing, though accelerated, is very time-consuming. To tackle this, we recently purchased a pressure cooker as correlations between 2000 hours DHT and 4-day pressure cooker test (PCT) have been reported. Concerning the LMGP, the Spatial ALD team has used oxide coating to encapsulate and protect silver nanowire networks against thermal and electrical degradation, and more recently against ambient degradation. SALD coatings have also proven to be efficient passivation layers for the edges of Silicon-based solar cells.

### MAIN MISSIONS

The doctoral researcher will benefit from IPVF and LMGP expertise and unique capabilities in both ALD material development and photovoltaics.

She/he will integrate two dynamic and talented teams driven by innovation and results. Using their unique capabilities, her/his main missions will consist in the development of efficient barrier layers for solar cells, ie:

- Development of nanolaminates of inorganic layers ( $Al_2O_3$ ,  $TiO_2$ ,  $SnO_2$ ,  $ZnO$ ) or nanolaminates of hybrid inorganic-organic layers (alucone, titancone, tincone, zincone, ... ), taking advantage from the capability of ALD technique to deposit conformal and dense film with thickness control at the nm level
- Characterization of the main material properties required for efficient encapsulation to identify best material solution and understand their behavior
- Transfer of the best material solutions into a Spatial ALD system
- Acceleration of the development of efficient encapsulation solutions by exploring and challenging the correlations between 2000 hours DHT and 4 days PCT.

### SOUGHT PROFILE

Knowledge	Know-how	Self-management skills
<ul style="list-style-type: none"> <li>▪ Materials science</li> <li>▪ Optical instrumentation</li> <li>▪ Thin film characterization</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hands-on experience with thin films would be a plus</li> <li>▪ Data treatment</li> <li>▪ Communication of results</li> </ul>	<ul style="list-style-type: none"> <li>▪ Curious and enterprising</li> <li>▪ Autonomous</li> <li>▪ Organizational and collaborative skills</li> <li>▪ Results-oriented</li> </ul>

### CONTACT

Cover letter, academic records and résumé (including the name and contact details of at least two references) to be sent to: [n.schneider@cnr.fr](mailto:n.schneider@cnr.fr) and [david.munoz-rojas@genoble-inp.fr](mailto:david.munoz-rojas@genoble-inp.fr)

