PhD offer from the NANO-EH EU Project:

Development of smart energy harvesters for next generation internet-of-things

The Institut FOTON proposes a Ph.D. subject about the development of advanced solar cells and rectennas for next generation of internet-of-things.

Starting date: September 2020, for a 3-years period

Co-Supervision: Olivier Durand & Antoine Léoublon
Funding: EU Project NANO-EH (EIC Pathfinder: FET Proactive - Boosting emerging technologies)
Keywords: design and simulation of solar cells, Material characterisation of thin films, Characterisation of energy harvesters, HfZrOd/HfZrOf rectennas, MoS$_2$/Si heterojunction solar cells.

Project description:

The 4th Industrial Revolution (4IR) builds on the Internet-of-Things (IoT) paradigm, as it relies upon the scenario of having billions of interconnected autonomous mobile devices, with unprecedented processing power, storage capacity and access to knowledge. The integration of these emerging technologies into everyday life requires efficient power supply solutions in computing, sensing, memory enlargement and human-machine interaction. One perceived bottleneck for 4IR is that in most situations, IoT devices/networks will be remotely deployed, so that maintenance may be either inconvenient or impossible. In particular, this implies that IoT devices either have to embed energy sources consistent with their operative lifespan or that clean and renewable energy converters, if working off-grid, must sit on board. It implies advanced solar cell and rectennas engineering for scalable miniaturized energy harvesting submodules that are tailored for the specific needs of stand-alone, mobile or portable uses. It surpasses the current paradigm of energy harvesting materials by developing non-toxic and rare earth/lead-free materials exhibiting CMOS-compatibility and scalability for low cost and large-scale manufacturing. The solar cells and the rectennas will be developed from emerging classes of energy harvesting nanomaterials, such as HfZrOd/HfZrOf [1-3] and 2D MoS$_2$ [4-5].

In this context, the OHM research team (INSA research unit), which has a recognized expertise in the mastery and understanding of advanced solar cells [6-8] proposes a thesis to work on the development of HfZrOd rectennas [9-10], MoS$_2$/Si heterojunction solar cells [11-12].

To this aim, the doctoral student will work on three main aspects:
- simulation of 2D MoS$_2$/Si heterojunction solar cells properties for optimization of their design,
- material characterizations of the MoS$_2$ and HfZrOd thin films and related nanostructures (XRD, XRR, AFM, ellipsometry)
- characterizations of the energy harvesters (light I-V, dark I-V, EQE, IQE).

Qualifications

The applicant should have a master's degree, or an engineering degree, ideally justifying basic knowledge in materials physics and optics and in energy harvesters. The applicant should have an interest in the experimental work and secondly in the modeling work and computing for data handling. Good communication skills in English are required.
Partnership

Besides all the 10 project partners, this work will mainly rely on collaborations with Tyndall Institute (Ireland) for the ALD process development of wafer-scale HfZOf/HfZrOd and ALD/CVD 2D MoS2, the microstructural and optical characterisation of materials and the fabrication and characterisation of devices and demonstrators, with IMT (Romania) for the fabrication of the RF rectenna harvesters and Thales Research and Technology for end users requirements and devices benchmarking.

The PHD will be supervised by both Olivier Durand and Antoine Létoublon at Institut FOTON.

About Institut FOTON (CNRS, UMR6082)

Institut FOTON is a research unit of the French National Centre for Scientific Research (CNRS) associated to University of Rennes 1 and the National Institute for Applied Sciences (INSA) of Rennes. FOTON is composed of three research teams: the "Optoelectronics, Heteroepitaxy and Materials" team, the "laser Dynamics, microwave photonics, Polarimetry, terahertz, imaging" team located in Rennes, and the "Photonic Systems" team located in Lannion. The two cities are located approximately 170 km apart, in the province of Brittany, Western France. The OHM research team has an established reputation in the area of advanced materials for photonics, photovoltaics or energy conversion applications.

The successful candidate will carry out research at INSA-FOTON team based at INSA Rennes, France.

More information can be found about institut FOTON at foton.cnrs.fr

Further information-Contact

Further information may be obtained by contacting: antoine.letoublon@insa-rennes.fr (X-ray scattering development at FOTON) or Olivier.durand@insa-rennes.fr (head of Photovoltaic field of research)

Application

Please submit before July the 15th, by providing us:
- a letter of motivation
- a curriculum vitae with at least 2 recent reference persons
- a copy of you master’s degree or equivalent diploma

References