

Research Topic for the ParisTech/CSC PhD Program

Field: Applied Physics

Subfield: Chemistry

ParisTech School: Ecole polytechnique

Title: Synthesis of catalysts for hydrogen fuel cells coupled with silicon nanowire solar cells

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Short description of possible research topics for a PhD: Production of hydrogen fuel with the assistance of solar energy attracts a lot of attention today because of the ongoing reduction of fossil fuel resources and their inherent pollution. Hydrogen production assisted by solar energy promises a renewable source of fuel which offers a complete energy circle, where water is a source of fuel as well as the byproduct of the hydrogen combustion.

In order to achieve efficient hydrogen fuel production, we aim at developing solar cells that will feed in energy a fuel cell to obtain an autonomous system. Particularly, this proposal proposes to develop silicon nanowire solar cells which can provide high open-circuit voltage in the tandem configuration and large surface areas for more efficient catalysis. They will be fabricated by a low-cost plasma enhanced chemical vapor deposition technique. Based on our experience of carbon nanotubes functionalization, the project also proposes to develop new carbon electrodes made of carbonaceous materials functionalized with metallic nanoparticles that will serve as catalysts for water splitting.

This multidisciplinary work includes i) the synthesis and characterization of catalytic materials; ii) the elaboration of tandem silicon nanowire solar cells based on a combination of materials comprising Si and Ge; iii) the characterization of the devices as far as hydrogen production is concerned.

Required background of the student: Student is required to have a good background in material science with a strong will to develop a multidisciplinary project. Very good communication skills in English and ability to work in team are also required. Motivation of the student to learn a wide variety of techniques will be considered as the most important criterium for selection. Enthusiasm towards renewable energy, solar cells and storage is highly appreciated.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

- S. Misra, L. Yu, M. Foldyna, P. Roca i Cabarrocas, *Solar Energy Materials and Solar Cells* **118**, 90 (2013).
- S. Misra, L. Yu, W. Chen, M. Foldyna, P. Roca i Cabarrocas, *Journal of Physics D: Applied Physics* **47**, 393001 (2014).
- S. Misra, L. Yu, M. Foldyna, P. Roca i Cabarrocas, *IEEE Journal of Photovoltaics* **5**, 40 (2015).
- A. S. Togonal, M. Foldyna, W. Chen, J. X. Wang, V. Neplokh, M. Tchernycheva, J. Nassar, P. Roca i Cabarrocas, Rusli, *Journal of Physical Chemistry C* **120**, 2962 (2016).
- M. Foldyna, A. S. Togonal, Rusli, P. Roca i Cabarrocas, *Solar Energy Materials and Solar Cells* **159**, 640 (2017).