

Title of the thesis	Catalysis Inducing Diodes (CID) for sustainable chemistry
Acronym	CID
Reference number	017

Hosting institution	Employer
Université de Lille Website: https://www.univ-lille.fr/home/	CNRS Website: http://www.cnrs.fr/en
Hosting research unit 1	Hosting research unit 2
<u>Name:</u> Unité de Catalyse et de Chimie du Solide <u>Acronym:</u> UCCS <u>Identification number:</u> UMR 8181 <u>Address:</u> Université de Lille Bâtiment C3 59655 Villeneuve d'Ascq Cedex <u>Website:</u> http://uccs.univ-lille1.fr/index.php/en/ ; http://suscat.org	<u>Name:</u> Institut d'électronique de microélectronique et de nanotechnologie <u>Acronym:</u> IEMN <u>Identification number:</u> UMR 8520 <u>Address:</u> Cité Scientifique Campus Avenue Henri Poincaré CS 60069 - 59 652 Villeneuve d'Ascq <u>Website:</u> https://www.iemn.fr/
Principal supervisor	Co-supervisor
<u>Name:</u> Vitaly <u>Surname:</u> ORDOMSKY <u>Email:</u> vitaly.ordomsky@univ-lille.fr <u>Phone:</u> +33 7 81 69 89 92	<u>Name:</u> Bruno <u>Surname:</u> GRANDIDIER <u>Email:</u> bruno.grandidier@iemn.fr <u>Phone:</u> +33 3 20 30 40 14

Thesis information	
Keywords	diode, catalysis, water, carbon dioxide, splitting
Abstract	<p>Development of human economic activities, especially use of fossil resources in transportation, industry and household combined with deforestation and land-use changes have led to the continuous increase in the concentration of CO₂ in the atmosphere with strong greenhouse gas effect and change of the climate. The possible alternative to fossil fuels could be the application of renewable energy resources (wind, solar...) for the energy and chemical generation at mild conditions. These methods of transformation are usually based on photocatalysis using solar energy and electrocatalysis using electricity. The main disadvantage of photocatalysis is low quantum efficiency (2-5 %) with low selectivity to the target products. At the same time, electrocatalysis is hard to implement for the activation of stable molecules in the gas phase catalytic reaction. In this project, we propose to take advantage of both photo and electrocatalytic concepts by the implementation of catalytic diode. Opposite to a catalytic nanodiode, which produces electricity from a catalytic reaction, the diode will consist of a porous semiconductor catalyst inserted in a <i>p-n</i> junction to lead to catalytic reactions from the efficient and controlled electron and hole injections into the semiconductor catalyst. This concept should:</p> <ul style="list-style-type: none"> ✓ increase the overall efficiency for the catalytic reactions and ✓ control the reaction using the electrical potential applied to transfer charge carriers from the electron and hole-transport interlayers. <p>The project will be focused on the development of Catalysis Inducing Diodes (CID) to perform catalytic reactions by a combination of chemistry (UCCS laboratory) and electric engineering (IEMN laboratory) in Lille University. The diode will be designed with low-cost technological processes, that rely on the use of solution-processable stable inorganic nanoparticles to build each interlayer as well as the catalyst layer. It will be operated for catalytic reactions of water (H₂O) and carbon dioxide (CO₂)</p>

	<p>splitting to produce hydrogen (H₂) and carbon monoxide (CO), respectively, as the target products. These are valuable products in fuel and chemical industry that are produced nowadays by high temperature (700-900 °C) conversion of fossil fuels like methane reforming with the generation of CO₂ as a side product. The application of diodes for these catalytic could be an important green alternative to existing industrial processes.</p>
<p>Expected profile of the candidate</p>	<p>Responsibilities and tasks</p> <p>The main responsibility of the PhD student will be design and development of Catalysis Inducing Diodes (CID) for their subsequent application in catalytic splitting of water and CO₂. The project is a collaboration between chemistry (UCCS) and electronic engineering (IEMN) laboratories. The candidate will be expected to carry out an external research stay in Ghent University of Belgium as part of the scholarship.</p> <p>Qualifications</p> <p>The candidate must have achieved a master's degree or equivalent in chemistry or electronic engineering. Preferably candidate should have background in both fields. The candidate is a highly motivated, enthusiastic researcher and has a strong interest in scientific research and learn new skills. Fluency in written and spoken English is required. The successful candidate should be able to work independently and cooperate with other researchers in this interdisciplinary project. The project will require strong attitude of candidate to study new disciplines and new methods in order to successfully fulfill the project.</p> <p>The applicant should strive towards scientific excellence, be ambitious and hard working. Only applicants who seek to be amongst the brightest in their field and conduct science at the highest international level will be considered.</p> <p>Specifically, in the framework of the project the candidate should be able to:</p> <ul style="list-style-type: none"> ✓ Conclude base on catalytic results and CID structure their relations and come up with plans and solutions for development of concept (analytical thinking); ✓ Come up with innovative ideas and concepts for development of CID and its application (creativity); ✓ Manage the project in terms of planning and organization of experiments and dissemination of the results including self-management (management and independence); ✓ Explain his results and transfer ideas in interdisciplinary team (communication); ✓ Collaborate, negotiate and influence other people in open way and transfer knowledge between different teams (working with others and teaching); ✓ Speak, read and write advanced level English to be able to present results in the form of publications and conferences (language). <p>Conditions</p> <p>The candidate is offered a full-time position for 3 years. The work time will be shared between UCCS and IEMN laboratories in Lille (France). The candidate will work together with PhD students and postdocs from UCCS and IEMN teams in the fields of catalysis and diodes design, respectively.</p> <p>The candidate will have secondments in the laboratory of Ghent University for the modelling of the process and company Horiba to perform additional characterization and compare new concept with existing refinery industrial processes.</p>
<p>Application procedure & Eligibility criteria</p>	<p>The application procedure and eligibility criteria are detailed on the European doctoral programme PEARL website www.pearl-phd-lille.eu. The funding is managed by the I-SITE ULNE foundation which is a partnership foundation between the University of Lille, Engineering schools, research organisms, the Institut Pasteur de Lille and the University hospital.</p>

	The application file will have to be submitted before March 31, 2021 (10:00 AM - Paris Time) and emailed to the following address : international@isite-ulne.fr .
Net salary and Lump Sum	A net salary of about €1,600 + €530 per month to cover mobility, travel and family costs.