Master internship/PhD

Internship/job title	**Disorder effects in nitrides-based electronic devices**
Location :	Laboratoire PMC – Ecole Polytechnique – Route de Saclay – 91128 Palaiseau
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Observations	Starting date : January – March 2019

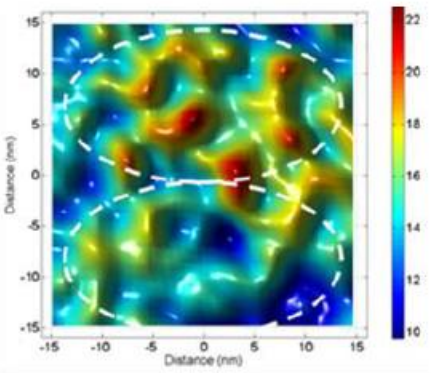

Fig.1: In-plane variation of indium content within the active layer of a blue InGaN LED.

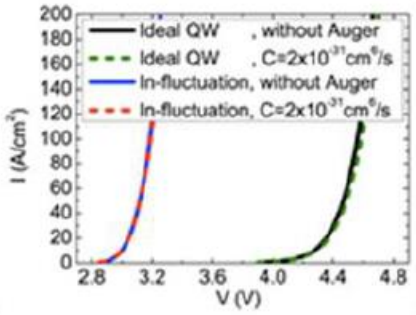

Fig.2: Simplified simulation of the I(V) curve of a LED including disorder (left) and using a commercial LED software (right). The modeling of the turn-on voltage with disorder is still 0.4V higher then experiment.

TOPIC: There is growing evidences that alloy disorder (Fig. 1) controls to a large extent the electrical and optical properties of semiconductor heterostructure. In particular the disorder-induced localization effects is suspected to be a main cause that limits the performances of InGaN light-emitting diodes. It is therefore of primary importance to address this issue as huge energy savings are concerned. However, the disorder effects on the carrier dynamics are an insurmountable task for today's modeling tools (right curve of Fig.2). At the same time, the experimental investigation of disorder effects is not trivial as well since the typical disorder length scale, as shown in Fig.1, is in the nm range [1].

We recently proposed a new and powerful theoretical approach to describe localization in disordered systems [2]. This approach allows determining the localization landscape, the corresponding energies and electron-hole overlap, for various structures and composition distributions in the semiconducting alloys.

The intern will apply this method to the modeling of disordered, real-world devices. The work will consist in carrying on theoretical calculations as well as numerical simulations to determine the localized states and compute the electronic transport and the recombination processes. The intern will also conduct experiments on actual devices and on specific structures, by means of unique low-energy electron spectroscopy and microscopy techniques [3,4,5], which will provide a feedback to the model.

This activity is part of a collaborative project, funded by International cooperative contracts between the LPMC at Ecole polytechnique, the National Taiwan University, and the University of California in Santa Barbara. The work is mainly located at LPMC. Travels to NTU and UCSB might be necessary for the project, which will be supported by LPMC.

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[1] Y.-R. Wu et al., Appl. Phys. Lett. **101**, 083505 (2012)
[2] M. Filoche and S. Mayboroda, Proc. Natl. Acad. Sci. USA **109**, 14761 (2012)
[3] J. Iveland et al., Phys. Rev. Lett. **110**, 177406 (2013)
[4] M. Piccardo et al., Phys. Rev. B **89**, 235124 (2014)
[5] W. Hahn et al., Phys. Rev. B **98**, 045305 (2018)

CANDIDATE & POSITION: Methods to be used include low energy electron spectroscopy. Funding for a subsequent Ph.D. may be via a ministry Ph.D. scholarship, the ANR or an external funding agency.

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