Internship proposal

Internship title	**Disorder-induced localization effects in nitride compounds and devices**
Location	Laboratoire PMC – Ecole Polytechnique – Route de Saclay – 91128 Palaiseau
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Web site	http://pmc.polytechnique.fr/spip.php?article549&lang=en
Comments	Possibility to go on with a PhD ? Yes Envisaged fellowship ? Ministerial scholarship, AMX, AMN

PROJECT :

There is growing evidences that alloy disorder (Fig. 1) controls to a large extent the electrical and optical properties of semiconductor heterostructures. In particular the disorder-induced localization effects are 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 modelling tools. 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 apply 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 realistic structures and composition distributions. Relevant experiments are now required to confront theoretical predictions with the actual properties of real-world devices.

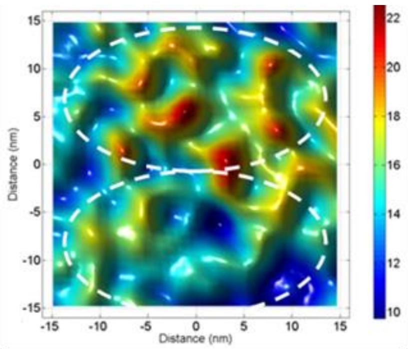

Figure 1 : Measured in-plane variation of indium content within the active layer of a blue InGaN LED. Color scale is in %.

We propose to study localization effects on the transport and recombination in InGaN/GaN quantum well (QW) structures by means of scanning tunnelling luminescence microscopy and spectroscopy. In this experiment, carriers are injected locally in the material from the tip of a scanning tunnelling microscope capable of atomic resolution. Carriers are then captured in the InGaN QWs and recombine radiatively. The emitted light is analyzed with an optical spectrometer. This provides a direct mapping of the recombination processes in the material with a resolution that fits with the localization scale.

This activity is part of a collaborative project, funded by the ANR, involving the LPMC at Ecole polytechnique, the National Taiwan University, and the University of California in Santa Barbara. The work will be mainly located at the LPMC. Travels to UCSB where samples are fabricated (and possibly to NTU) might be necessary for the project.

[1] Y.-R. Wu et al., Appl. Phys. Lett. 101, 083505 (2012)

[2] M. Filoche and S. Mayboroda, Proc. Natl. Acad. Sci. USA 109, 14761-14766 (2012)