Scanning μ-x ray excited luminescence in semiconductors

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A new microprobe approach based on x-ray excited luminescence is introduced, demonstrating that luminescent mapping and spectroscopic analysis on semiconductor layers can be also coupled with elemental sensitivity on a microscopic scale.[1] We have applied this new method principally to the study of nitride based films: Mn doped GaN and free-standing GaN.[2] Owing to their wide-bandgap, polarization-based effects, and superior mechanical, magnetic and thermal properties, group III nitrides provide a promising material for optoelectronics devices. Basically in the UV optical range, their luminescence presents astonishing properties with potential applications in new and sophisticated technologies (laser diodes and light emitting diodes). However, a deep understanding of the phenomena involved is still required to allow their full exploitation in the generation of systems with pre-established properties. By imaging and dispersing simultaneously x-ray fluorescence and luminescence excited by synchrotron radiation, this novel approach opens new facilities to the semiconductor research community. Investigation of multiexciton states in quantum dots by non-linear excitation, site and chemical environment in quantum wires by x-ray absorption spectroscopy and x-ray excited optical luminescence, elemental homogeneity by x-ray fluorescence [3] are just a few examples of the potentialities of this technique. Despite the complexity of the energy relaxation and transfer processes, which limit its potential as a detection scheme, there remains a lot of exciting physics to be investigated.

[1] G. Martinez-Criado, B. Alen, A. Homs, A. Somogyi, C. Miskys, J. Susini, R. Tucoulou, J. Pereira, J. Martinez-Pastor, *Scanning X-ray excited optical luminescence microscopy: new mapping technique to characterize optical inhomogeneities,* Submitted to Applied Physics Letters.
[2] G. Martinez-Criado, A. Somogyi, S. Ramos, J. Campo, R. Tucoulou, M. Salome, J. Susini, M. Hermann, M. Eickhoff, and M. Stutzmann, *Mn-rich cluster in GaN: Hexagonal or cubic symmetry?* Appl. Phys. Lett. **86** 131927 (2005).
[3] G. Martinez-Criado, A. Somogyi, M. Hermann, M. Eickhoff, and M. Stutzmann, *Direct observation of Mn clusters in GaN by x-ray scanning microscopy,* Jpn. J. Appl. Phys. **43** L695 (2004).