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Reestablishing the photoluminescence lab at ISOLDE: Is there a link between photoluminescence and emission channeling?

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Photoluminescence (PL) is an optical, non-destructive technique that is often used to characterize the defects in semiconductors. However, the proper chemical identification for the origin of signals can be misleading. Implanting samples with radioactive probes at ISOLDE allows for a clear chemical classification of a peak in a PL spectrum as its intensity changes with time. In this work we present the reestablishment of a PL setup at ISOLDE and progress towards its thorough testing.

The setup consists of three main components a HeCd laser for excitation of the sample, a cryostat, where the sample was mounted and a spectrometer to which two detectors were attached, a CCD (for the visible range) and an InGaAs (for the infrared range). Some miscellaneous optical components were also used to redirect and focus the beam. Multiple mounting methods of the samples were also tested.

The samples studied were mainly of GaN, with different doping characteristics, and diamond. Some of the samples were previously used in emission channeling (EC) experiments allowing for a simultaneous search for a link/correlation between PL, a global technique, and EC, a local technique. From the PL spectra of the n-GaN:Si sample, recorded at multiple positions, it was possible to see that the doping had changed to almost intrinsic in its middle but not in the other positions. The change is due to the implantation of stable Mg in this sample during EC experiments. As the implantation concentration of stable Mg was approximately equal to the initial concentration of Si on the sample, for the behavior to become intrinsic most of the implanted Mg had to be in its active location on the lattice, the substitutional position. This is in agreement with the EC experiments completed on this sample, which found that approximately 95% of the 27Mg implanted was substitutional in n-GaN:Si.

Besides the link found between EC and PL, the work has led to a fully functional PL setup at the ISOLDE facility. Python scripts have also been developed which automate part of the measuring and analysis processes.

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