Project 6.3. Semiconductor nitride light emitters with polarization doping

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Description:
Semiconductor light sources, including those based on AlInGaN nitride semiconductors, are usually based on the p-i-n junction and quantum light-emitting structures. Unfortunately, wide-gap semiconductors are difficult to effectively dope, usually this difficulty applies in particular to the p-type. In gallium nitride the only effective acceptor is magnesium and even this has a relatively high ionization energy of 160 meV. The situation becomes even more difficult in the case of AlGaN, a material important for lasers and light emitting diodes operating in the UV range. In this material, ionization energy becomes even higher than 500 meV, causing serious difficulty in the device preparation.
For this reason, obtaining a good hole conductivity in AlGaN structures is a huge challenge for material engineering of these compounds.
The idea behind this project is the use of strong dielectric polarization in nitride materials. Gradients of composition in these structures translate into polarization gradients and those to non-zero polarization charge, which can act as doping.

Aim:
The aim of the project is to exploit epitaxial structures having a vertical composition gradient, mainly in AlGaN layers and to use them to obtain better doping in lasers and light-emitting diodes.
The project would consist of three paths:
A) Modeling and design of structures with polarization doping.
B) Epitaxy of these structures.
C) Electric and optical characterization of these structures.

The final goal would be to demonstrate devices with very low operating voltage and increased reliability, with no or limited classical p-type doping.

Requirements:
It is advisable to complete a master's degree in the field of physics or related subjects, knowledge of semiconductor physics, predispositions for experimental and theoretical work.