Optimization of ohmic contacts to AlGaN for LEDs and VCSELs

Background

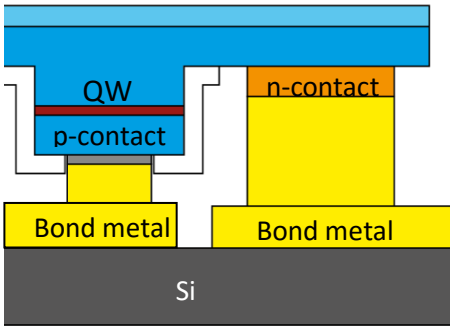
Highly efficient GaN-based blue-emitting LEDs are dominating the market for visible-lighting and several research groups have reported electrically injected GaN-based vertical-cavity surface-emitting lasers (VCSELs). On the contrary, AlGaN LEDs emitting in the ultraviolet B and C (UVB, UVC) regime still suffer from poor efficiencies and up until recently there were no demonstrations of UVB- or UVC-emitting VCSELs, even under optical pumping. At the Photonics Laboratory at MC2, we have developed a successful method to underetch and remove AlGaN films with precisely controlled thicknesses from their native substrate. Using this method, we have demonstrated UVB thin-film flip-chip (TFFC) LEDs and the world's first UVB-emitting VCSELs. However, to enable electrical injected AlGaN-based VCSELs and further improve the performance of the TFFC LEDs, optimization of the electrical contacts is needed. To improve the efficiency and lifetime of LEDs and VCSELs, resistive losses in the electrical contacts needs to be low. UV VCSELs will use tunnel junctions and therefore have two n-contacts, one on etched and one on as-grown AlGaN, while TFFC LEDs use both p- and n-contacts. For LEDs, it is also beneficial if the p-contact has a high optical reflectivity.

Thesis scope

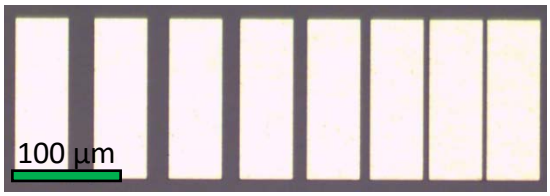
The goals of this thesis are to achieve ohmic contacts to etched n-AlGaN, as-grown n-AlGaN, and as-grown p-(Al)GaN, with as low as possible contact resistances. This will be done by optimizing the contacts in terms of the metals used, their thicknesses, and thermal annealing conditions. Potentially, the reflectivity of the p-contacts could also be measured.

Methods

You will work in Chalmers' state-of-the-art cleanroom to fabricate transmission line method (TLM) patterns that you will use to measure the contact resistance. The fabrication and characterization include dry etching of AlGaN, photolithography, metal evaporation, rapid thermal annealing, and IV-measurements.



An UV-emitting thin-film flip-chip LED



Fabricated TLM-pattern which is used to measure contact resistance to e.g. AlGaN

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