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CHEMICAL NATURE OF N-IONS INCORPORATED INTO EPITAXIAL ZnO FILMS

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Efficient p-type doping of zinc oxide (ZnO) is hindered on the one hand by the strong native n-type doping of the ZnO, on the other hand, compensation effects (defect generation due to p-doping) tend to preserve the n-type doping. Incorporation of nitrogen is proposed as a promising method to achieve p-type ZnO, because the ionic radii of nitrogen and oxygen are comparable. Therefore, nitrogen atoms can replace oxygen. Nevertheless, a reliable and stable p-doping is still an unmatched challenge.

This work will focus on the chemical nature of nitrogen implanted by ion irradiation into MO-MBE grown ZnO layers on sapphire substrate. The incorporated nitrogen was investigated by photoelectron spectroscopy using synchrotron radiation (PES) and monochromatized Al-Kα (mXPS), and X-ray absorption spectroscopy (NEXAFS). The preparation conditions were varied for preferential incorporation of the different nitrogen species. The three main N1*s*-PES components were assigned to different nitrogen compounds (molecular N_2, N-O-bonds, and N-Zn-bonds) with the help of NEXAFS data. In addition, the thermal stability of the nitrogen compounds was investigated. These results may lead to an optimization of the nitrogen implantation process for a better doping efficiency.

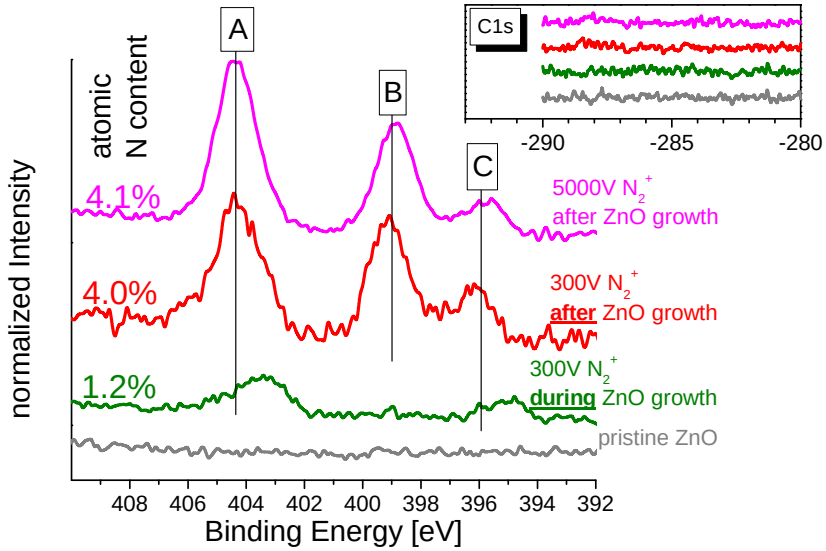

Figure 1. N1*s* spectra of nitrogen doped ZnO, grown by metal-organic MBE (MO-MBE), taken with monochromatized Al-K_α excitation. The nitrogen was implanted (15 minutes for each sample) from a plasma ion source with a kinetic energy of 300 eV while (lower spectrum), and after (middle spectrum) the MO-MBE growth of the ZnO. At higher kinetic energy of the nitrogen ions, the nitrogen content is not significantly increased, but the crystalline quality of the layer (checked by LEED) is nearly lost. Additionally, the corresponding C1*s* spectra are given on the upper right corner.