Cross-sectional photoelectron spectromicroscopy measurements of quantum dimensional AlGaN/GaN heterostructures: spatially resolved band structure mapping

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In this work we demonstrate the spatially resolved band mapping of nanoscale heterostructure devices for the case of wide gap material system AlGaN/GaN which exhibits unprecedented stability and is particularly suitable for light emitting devices and microwave/radiofrequency high power applications. The issue of the band alignment in these devices attracts a lot of interest since they exhibit strong polarization fields and a high-density of sheet polarization charges. Up to date the control of the band alignment across such heterostructure devices was based on our theoretical knowledge and experimental access to this extremely important property of the devices was only indirect. Conventional photoemission commonly applied to measure the band bending and valence band offsets provides only the value of the band bending potential at the surface while the behavior of the bands in the bulk of the device remains unknown. With the advent of photoemission microscopes it became conceivable to visualize the band alignment of semiconductor devices in cross-sectional samples. To overcome the limits of spatial resolution (now photoemission from 200 nm spot at the scanning photoelectron microscope of Elettra synchrotron light source is possible) we elaborated the procedure to fit the model band alignment (fig.1) 'broadened' by the *spatial apparatus function* of the instrument, i.e. the distribution of the photon flux inside the beam spot, to the experimental results: the function of Ga3d peak binding energy versus beam position obtained by carefully measuring the set of Ga3d spectra with the X-ray spot centered in different positions at the border of the cleaved heterostructure hereby reducing the effective size of the beam (fig.2).

Preliminary results on the AlGaN/GaN structures with different Al concentrations and further implications of the method will be discussed.

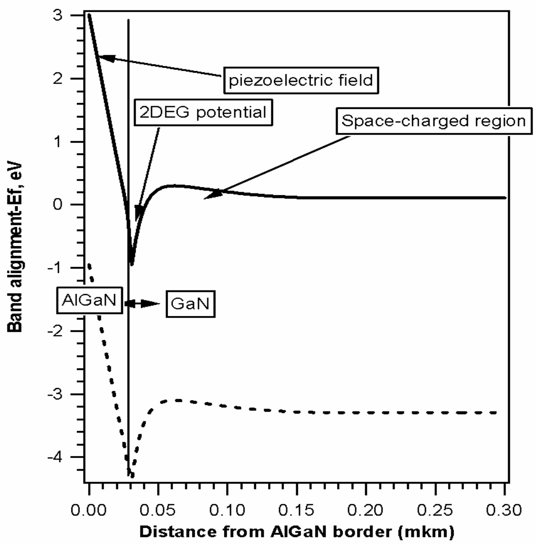

Figure 1. Model potential or VBM alignment (dashed line); CBM alignment (solid line).

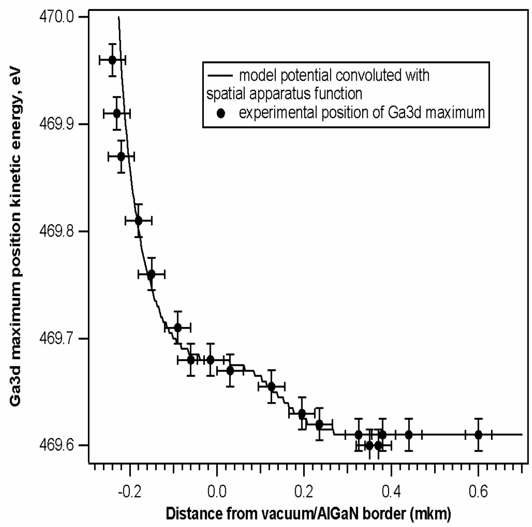

Figure 2. Energetic position of Ga3d maximum obtained from experiment (points) and after convolution of Ga3d shifted by model potential with spatial apparatus function.