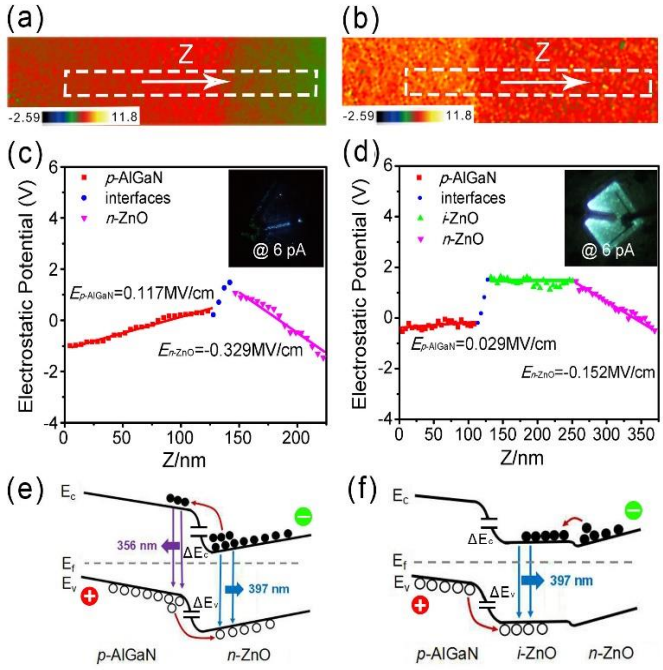
Tailoring of interface charges in semiconductor nanostructures

LI, L.[1]

[1] Huazhong University of Science and Technology, China



Tailoring of interface charges is a very important issue for semiconductor industry, which could be realized at the depletion region of the p-n junctions, around the heterostructural interfaces, and across the polytype homojunctions. The driving force of charge distribution could be electric fields, strain fields and band structure engineering, etc. Off-axis electron holography is one of the most appropriate technique for quantitative characterization of electrostatic fields and charge distributions.

Non-polar a-plane n-ZnO/p-AlGaN and n-ZnO/i-ZnO/p-AlGaN heterojunction film light-emitting diodes (LEDs) are studied by electron holography. After an insertion of an i-ZnO layer into the p-n heterojunction, comparatively flat electrostatic potential generates in the intrinsic ZnO region (Fig. 1) and contributes to faster movements of the injected electrons and holes, making the i-ZnO layer more conductive to the radiative recombination with enhanced exciton recombination possibilities and at last the LED performance enhancement[1].

Using electron holography, holes are found to confined near the base of the pyramidal Ge quantum dot embeded in Si substrate[2]. Hole accumulation is also discovered in the Ge core of a Ge/Si core/shell nanowire.[3] Quantitative analysis reveals larger hole density in Ge core of Ge/Si core/shell nanowire as compared to that in the Ge quantum dot.

Homogeneous Zinc blende (ZB)/Wurtzite (WZ) polytype interfaces in ZnSe nanobelts are studied by aberration-corrected high-angle annular-dark-field (HAADF) imaging techniques. The polarity continuity is determined

across the interface, and the saw-tooth-like potential profile is directly realved at nanometer scale, which is attributed to spontaneous polarizations.[4] Moreover, Polytype heterocrystalline structures within InAs nanopillars are also characterized by multiple TEM techniques. The electric field related to spontaneous polarization within the ZB region is revealed at nanometer scale using electron holography, and the measured value of spontaneous polarization for WZ-InAs is close to published results. Through probe-corrected HAADF imaging, strain-induced variations of local spontaneous polarization are determined with atomic resolution, which would provide valuable information for tailoring charge distribution in semiconductor nanostructures and for fabrication of future devices.[5]

References

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