Parametric analysis of KPFM by numerical simulation

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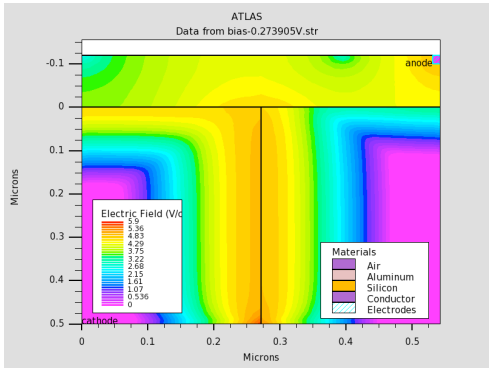
Abstract

Kelvin Force Probe Microscopy (KPFM) is a local scale advanced characterisation technique derived from atomic force microscopy. It allows measurement of contact potential of a surface with a resolution of the order of nanometres from which the work function and the Fermi level of the material can be measured and mapped.

Since it probes the surface, measurements are dominated by surface states. This paper presents a numerical study using SILVACO software using one and two dimensional parametric scans to study the impact of sample parameters on KPFM measurement of semiconductor materials.

The parameter scans include doping densities, thickness of defect layers, and amplitude, width, and energy of defect Gaussian distributions and band tail distributions of acceptor-type and donor-type defects. The technique is also applied to study surface photovoltage on pn-junction devices of group IV and group III-V materials.

The use of this technique in analysing experimental data is presented by modelling experimental data on homogeneous Si samples in the light and in the dark and by modelling III-V semiconductor samples.

(a) 

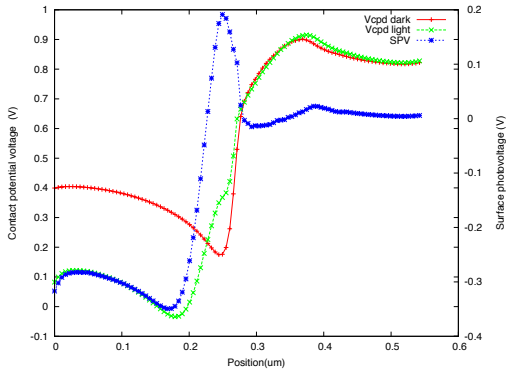
(b) 

Figure 1 KPFM simulation showing (a) a silicon pn structure (b) a cross-sectional simulation of surface photovoltage which is the difference of light and dark contact potential voltages.