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# Modelling investigations of surface photovoltage including surface defects

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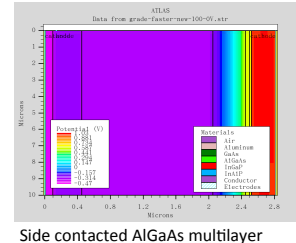
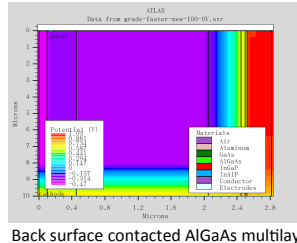
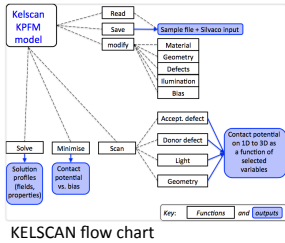
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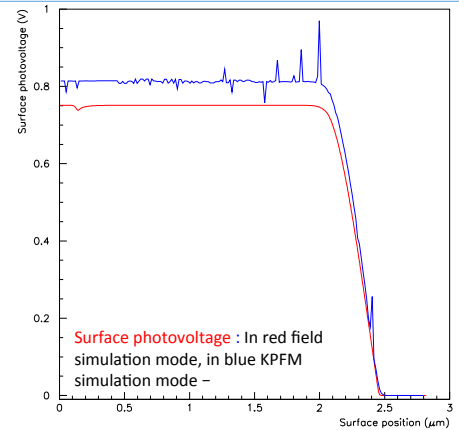
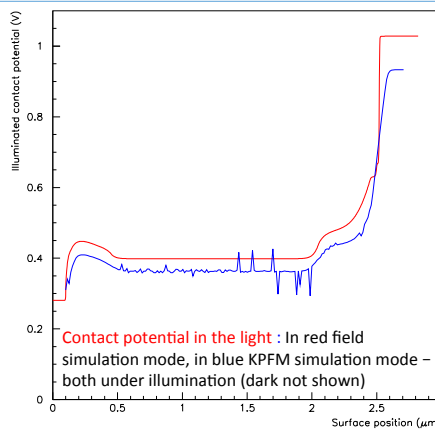
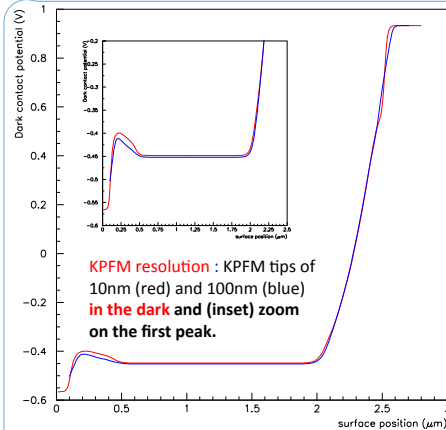
KPFM principles : see "Local probe microscopies for the study of III-V based solar cells", Mattia da Lisca et al., in this visual presentation session

KPFM - issues : Affinity, doping work function: BULK properties. Solution : Numerical modelling => KELSCAN modeling package (IPVF/GeePs)  
KPFM is SURFACE technique Including geometry, surface defects, characterisation techniques



Simulation methods : (1) KPFM experiment mode : Simulation of the KPFM tip, numerical field minimisation point by point  
(2) Field simulation mode : Numerical transport drift diffusion directly yields surface potential

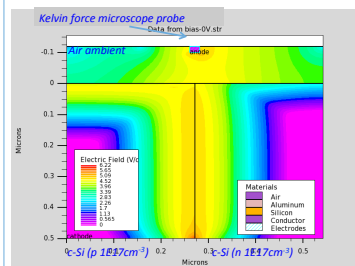
Simulation options: Arbitrary illumination Field profiles on four surfaces - KPFM scanning on top section  
Contacts on sides and / or back, kpfm tip on top section, option to remove contacts / tip



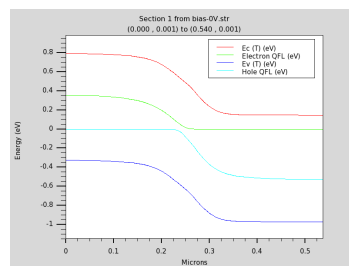
Evaluation of KPFM resolution : Weak dependence for two tip dimensions shown here in the dark

Simulation method : Full KPFM simulation is noisy in the light and subject to an offset due to contact issues to be investigated

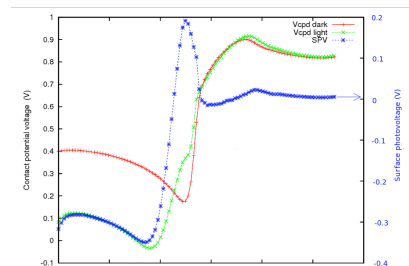
## pn junctions in the light with defective surfaces



Donor defects ND(peak) = 1e18/cm<sup>3</sup>(eV)  
Depletion mainly p-side (n-side doping gradient junction)



Bands and populations for donor defects



Sample : c-Si : [ p-1E17cm<sup>-3</sup> 0.27μm ][ n-1E17cm<sup>-3</sup> 0.27μm ] - Defect layer 0.1μm thick - Illumination 0.5μm monochromatic, 1000W/m<sup>2</sup>

## Discussion:

- Resolution : Simulation decouples transport issues inherently limiting resolution from KPFM tip influences.
- Simulation methods: Simulation of experiment required to validate resolution. Direct solution far more efficient if possible.
- Surface defects : Modification of potential CPD profiles due to surface defects can be simulated  
Challenge : knowledge of surface defect properties.
- In progress : Modulated spectrally resolved SPV

To be detailed in a follow-up JNPV publication in EPJ PV : Modification and explanation of CPD and SPV profiles due to defects