Solar Cell Diagnostics by Combination of Kelvin Force Microscopy with Local Photoexitation

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The modern high-efficiency multijunction solar cell (MJ SC) consists of three subcells based on semiconductor nanoheterostructures. This study using atomic force, Kelvin probe force and confocal microscopy demonstrates that the operation of each subcell could be monitored. The combination of methods used allowed measurement of the surface potential variations at the cross-section of multijunction solar cell as a function of the wavelength and the beam position of a laser excitation source focused into a ~400 nm spot. The experimental surface photovoltage profiles obtained are in good agreement with results of the qualitative simulation. This agreement is very important. Although the photoexcitation applied was significantly higher than operating photoexcitation, inside the structure no parasitic barriers were found that could lower the efficiency of the studied solar cells.

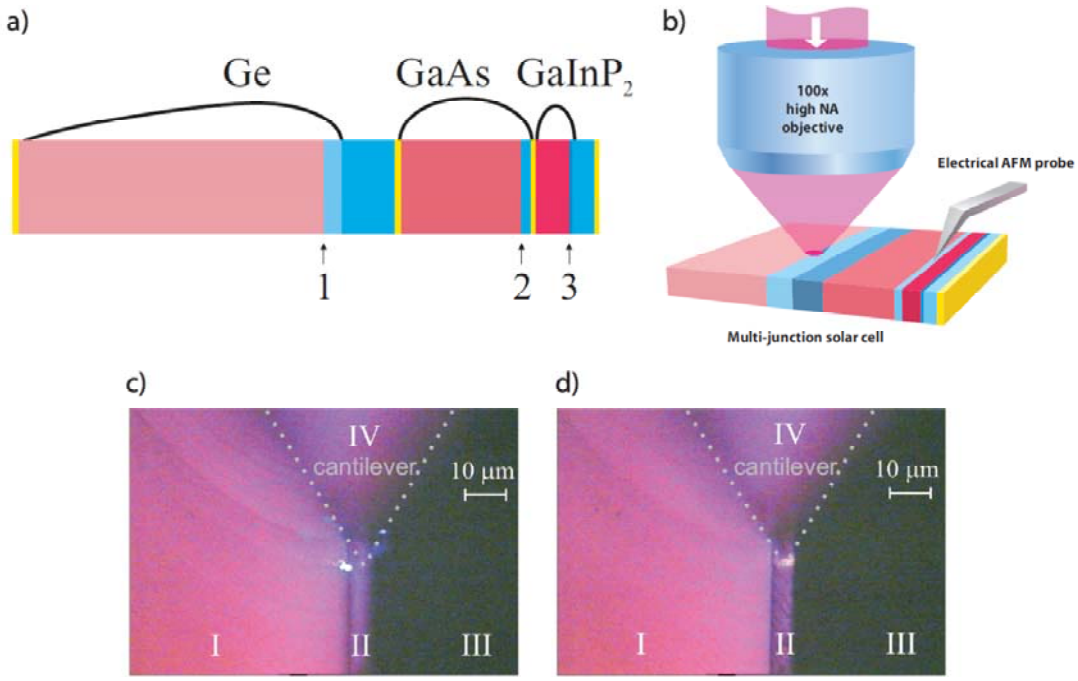

FIGURE. (a) Schematic of layers in an MJ SC. The three p-n junctions are shown by arrows. (b) Schematic of experiment. Optical micrographs of the edge of the cleaved surface of a SC during a KPFM experiment under focused photoexcitation of (c) the p-n junction in Ge with a blue laser (473 nm) and (d) p-n junction in GaAs with a red laser (785 nm). Latin numerals designate: (I) Ge substrate, (II) III-V layers (GaAs and GaInP), (III) free space,and (IV) KPFM cantilever.

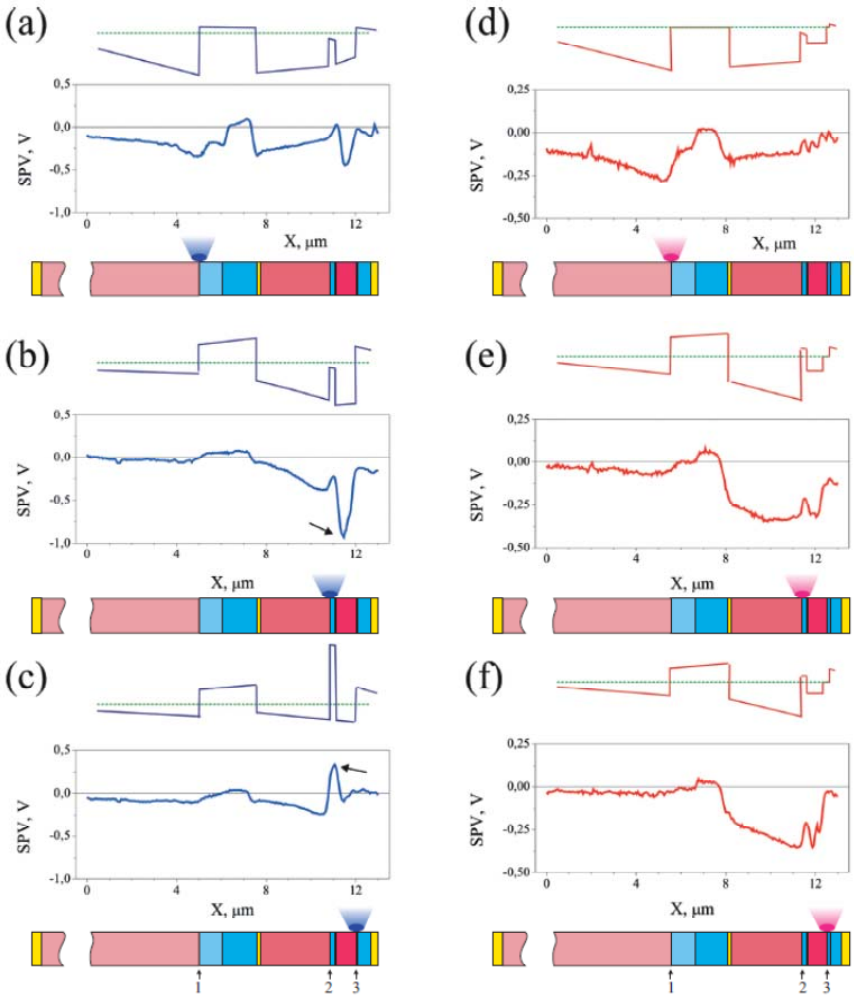

FIGURE. Comparison of experimental and simulated data. (a-c) Photoexcitation with laser light (473 nm) focused on the p-n junctions in (a) Ge, (b) GaAs, and (c) GaInP . (d-f) Photoexcitation with laser light (785 nm) focused on the p-n junctions in (d) Ge, (e) GaAs, and (f) GaInP . Designations: SPV, experimental surface photovoltage profile. A simulated profile is also given above each plot. Below, under all the plots are shown schematics of layers in MJ SCs.