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Title:Assessing charge carrier trapping in silicon nanowires using picosecond conductivity measurements

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Abstract:Free-standing semiconductor nanowires on bulk substrates are increasingly being explored as building blocks for novel optoelectronic devices such as tandem solar cells. Although carrier transport properties, such as mobility and trap densities, are essential for such applications, it has remained challenging to quantify these properties. Here, we report on a method that permits the direct, contact-free quantification of nanowire carrier diffusivity and trap densities in thin (∼25 nm wide) silicon nanowires - without any additional processing steps such as transfer of wires onto a substrate. The approach relies on the very different terahertz (THz) conductivity response of photoinjected carriers within the silicon nanowires from those in the silicon substrate. This allows quantifying both the picosecond dynamics and the efficiency of charge carrier transport from the silicon nanowires into the silicon substrate. Varying the excitation density allows for quantification of nanowire trap densities: for sufficiently low excitation fluences the diffusion process stalls because the majority of charge carriers become trapped at nanowire surface defects. Using a model that includes these effects, we determine both the diffusion constant and the nanowire trap density. The trap density is found to be orders of magnitude larger than the charge carrier density that would be generated by AM1.5 sunlight. © 2012 American Chemical Society.

Terahertz spectroscopy - Transport properties

Uncontrolled terms:Building blockes - Bulk substrates - Carrier diffusivity - Charge carrier trapping - Conductivity measurements - Diffusion constant - Diffusion process - Excitation density - Fluences - Nanowire surface - Orders of magnitude - Photoinjected carriers - Picosecond dynamics - Picoseconds - Processing steps - Semiconductor nanowire - Silicon nanowires - Silicon substrates - Surface passivation - Tandem solar cells - Terahertz - Trap density

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