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Minority Carrier Lifetimes and Surface Effects in VLS-Grown pn Junction Silicon Nanowires YEONWOONG JUNG, ALEKSANDAR VACIC, Yale University, DANIEL PEREA, TOM PICRAUX, Los Alamos National Laboratory, MARK REED, Yale University, YALE UNIVERSITY COLLABORATION, LOS ALAMOS NATIONAL LABORATORY COLLABORATION — We study the minority carrier lifetimes and surface effects of pn junction Si nanowires. Axial pn junction Si nanowires with alternating p-n doped segments are grown based on the Au-catalyzed VLS process by an in-situ exchange of gas-phase dopants. As-grown nanowires display strong current rectification only after surface etching processes. By utilizing the reverse recovery transient of minority carriers, we directly characterize the minority carrier lifetimes and observe the decrease of the lifetimes with a decrease of nanowire diameters. Investigation of the diameter-dependent device ideality factor and current density strongly suggests that the surface recombination with an enhanced surface-to-volume ratio significantly governs the carrier transport. We also characterize the carrier lifetimes of nanowires with and without surface passivation layers, and observe an enhancement of the lifetimes in the surface-passivated ones. These studies elucidate the carrier transport mechanism in VLS pn junction Si nanowires and emphasize the importance of the surface passivation for efficient photovoltaic applications.

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