Supporting Information

Silicon Nanowire Radial p-n Junction Solar Cells

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The starting wafer used to make the solar cells was {100} oriented, phosphorus-doped n-type Czochralski (CZ) Si, 550 microns thick and 0.6-0.8 Ω•cm (Montco Silicon Technologies). The wafer was scored into 1cm x 1cm squares with a wafer saw to allow for easy cleaving after fabrication. Nail polish was used around the edge of each square and on the back of the wafer as an etch mask so that the contacts could be made on planar Si to avoid damaging the wire arrays and shorting the cells. The etching solution was made by combining 2.99 g of silver nitrate (Alfa Aesar), 50 mL of 50% hydrofluoric acid (VLSI grade, Fluka), and 200 mL of 18 M Ω water (Millipore). The masked wafer was placed in an open Teflon dish with the etching solution and then heated to 50°C in an oven. After 2 hours the solution was drained and the wafer was rinsed 3 times with Millipore water followed by a 30 minute soak in Millipore water to ensure all the hydrofluoric acid was removed. The deposited silver was removed with 2 rinses and a 1 hour soak in concentrated nitric acid (Aldrich) followed by the same water rinse procedure mentioned above. During the nitric acid soak the etch mask delaminated as a single piece and was removed. The water was replaced by 10:1 ammonium fluoride to hydrofluoric acid solution and soaked for 10 minutes to remove any silicon oxide. The rinse procedure was repeated and then the water was exchanged with 2-propanol and the wafer was dried in air. The p-type a-Si was deposited on the n-Si nanowire array and on an oxidized silicon wafer in the Tystar20 low pressure chemical vapor deposition system in the Berkeley microfabrication lab. The deposition temperature was 450°C with 100 sccm disilane as the silicon source gas, 5 sccm boron trichloride as the dopant gas, and nitrogen as the diluent gas at a flow regulated by a feedback controller to maintain 300 mTorr total pressure during the 80 minute deposition. The film was uniform on the array and along the wires observed in TEM. The a-Si films were crystallized with rapid thermal annealing (RTA) in forming gas at 1000°C for 10 seconds. Figure S1 shows the x-ray diffraction patterns of the a-Si films before and after RTA crystallization. The p-Si was removed from the backside of the solar cell by an isotropic Si wet etch consisting of ammonium fluoride, nitric acid and water and then contacts were made to the n-Si backside using sputtered Ti (5nm)/Ag (200 nm) and to the p-Si front side using Ti/Pd (50/100 nm). In some devices, In/Ga eutectic alloy or In metal press contacts were used for one or both contacts without any significant change in device performance. All cells were tested using a 300W Oriel solar simulator with AM 1.5 filter at a power density of 100 mW/cm^2. The testing cell was made of black plastic and had a stainless steel screw for the back contact and a stainless steel disk with a 1cm x 1cm x 0.5mm inset to accommodate the test chip and a 5mm diameter circular hole in the center to allow for illumination. The 5mm diameter circular hole was used as the active solar cell area for all calculations; this entire area was exposed to light since the top contact metal was only applied underneath the metal disk at the sides of the solar cells.

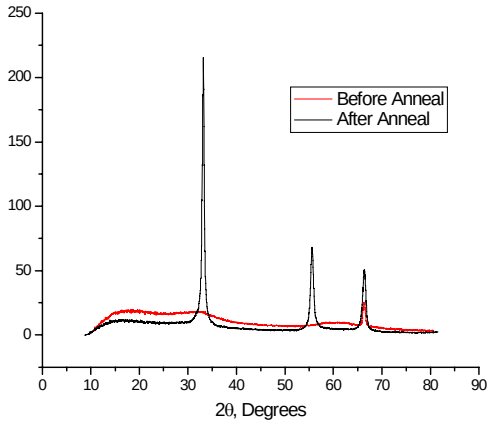

Figure S1. XRD showing the a-Si film before and after RTA crystallization.