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Vertically aligned silicon nanowires synthesized by metal-assisted chemical etching for photovoltaic applications

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Abstract content
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One-dimensional silicon nanowires (SiNWs) are promising building blocks for solar cells as they provide a controlled, vectorial transport route for photo-generated charge carriers in the device as well as providing anti-reflection for incoming light. Two major approaches are employed to synthesize SiNWs, namely the bottom up approach during vapour-liquid-solid mechanism or the top down approach via metal assisted chemical etching (MaCE). MaCE provides a simple, inexpensive and repeatable process that yields radially and vertically aligned SiNWs in which the structure is easily controlled by changing the etching time or chemical concentrations. During MaCE synthesis, a crystalline silicon (c-Si) substrate covered with metal nanoparticles (catalyst) is etched in a diluted HF solution containing oxidizing agents.

Since the first report on SiNWs synthesized via MaCE, various publications have described the growth during the MaCE process. However lingering questions around the role of the catalyst during formation, dispersion and the eventual diameter of the nanowires remain. In addition, very little information pertaining to the changes in crystallinity and atomic bonding properties of the nanowires post synthesis is known. As such, this study investigates the evolution of SiNWs from deposited metal nanoparticles by means of in-depth electron microscopy analyses. Changes in crystallinity during synthesis of the nanowires are probed using X-ray diffraction (XRD) and transmission electron microscopy (TEM). Deviations in the optical properties are quantified using reflectivity and absorption measurements, whereas the bonding configurations of the nanowires are probed by Raman and Fourier transforms infrared spectroscopy. Diameters of 100 – 300 nm vertical SiNWs were obtained from scanning electron microscopy with lengths changing with etching time (order of micrometres). Crystallinity remained unchanged as compared to the starting single crystalline Si wafer, findings confirmed by TEM and XRD analysis. These nanowires showed low reflection of less than 10% over visible range compared to an average of 30% for bulk Si.

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and his / her institution

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