Influence of nanostructure geometry on the effect of light trapping in solar cells

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The aim of this research was to detect the influence of the geometry of nanotips and silver nanoparticles on the plasmon light trapping and on the efficiency of solar cells with the radial p-n junction

Methods

- Si NWs array was fabricated on silicon (Si) of p-type (100), with the resistance of 10 Ohm×cm
- The Si nanowires were formed by MacEtch.
- Our mechanism of SiNW formation involves two subsequent processes: (a) deposition of Ag nanoparticles on the Si surface immersing them in the solution 0.02MAgNO3 + 5MHF + 100 ml H2O and (b) catalytic etching of Si at the sites where the Ag nanoparticles have been deposited in solution 1.15MH2O2+ 100 ml H2O + 5MHF.
- The morphology of the etched samples and the size of the nanotips were determined using scanning electron microscopy (SEM: model LEO440UP, Hitachis - 4800). We measured reflection using the spectrophotometer (Shimadzu, model UU3101PC). The reflectance measurements took place five times at different areas on the each sample.

Results

- The metal assisted chemical etching technology for Si NWs formation has been developed.
- Si NWs array formed at optimized conditions shows as low reflection as R < 1% in wide spectral range
- We have obtained nanotips of 1 to 2 μm in length and an average diameter of 50-100 nm.
- The absorption, transmittance and reflectance spectra for periodic nanostructures with different parameters have been calculated via the FDTD (Finite-Difference Time-Domain) method.
- Our research reveals the photoelectric properties of solar cells based on silicon nanotips with radial p-n junction with and without silver nanoparticles

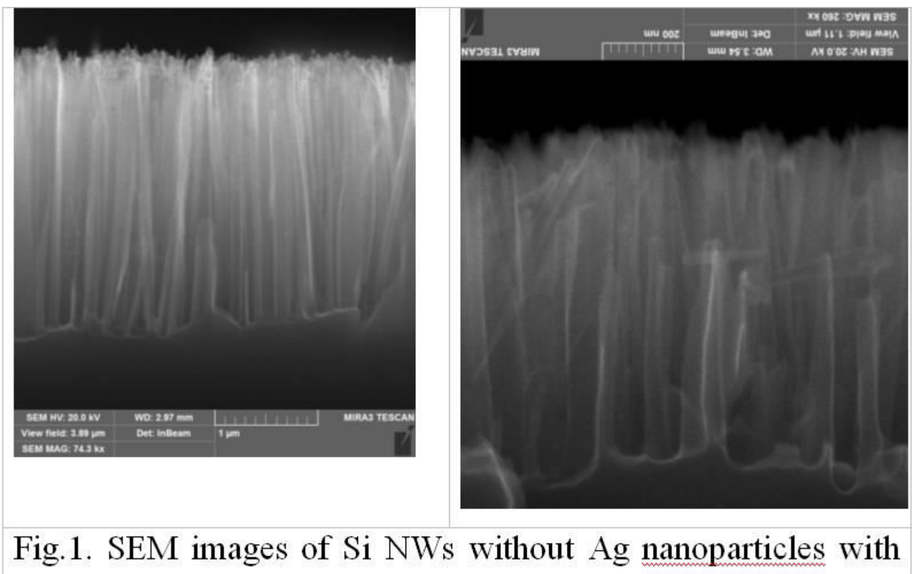

Fig.1. SEM images of Si NWs without Ag nanoparticles with different deposition time on the first stage a) t = 30 s; b) t =60 s. The etching time at the second stage was fixed at t = 30 min and fixed flushing time at t = 30 min.

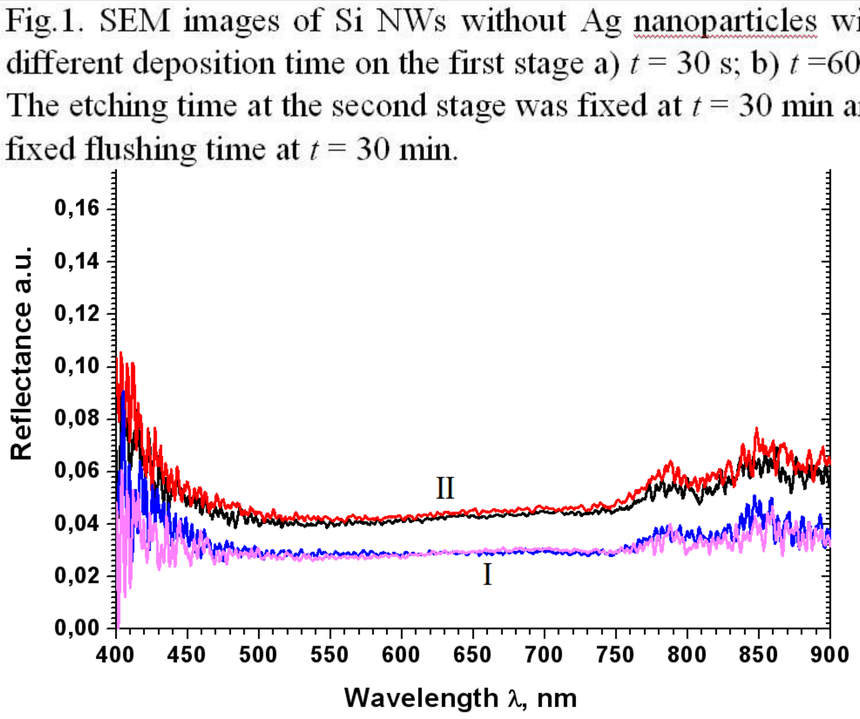

Fig. 4. The reflection spectra for SiNW with different deposition time a) I- with Ag nanoparticles,, II –without Ag nanoparticles, t = 60 s

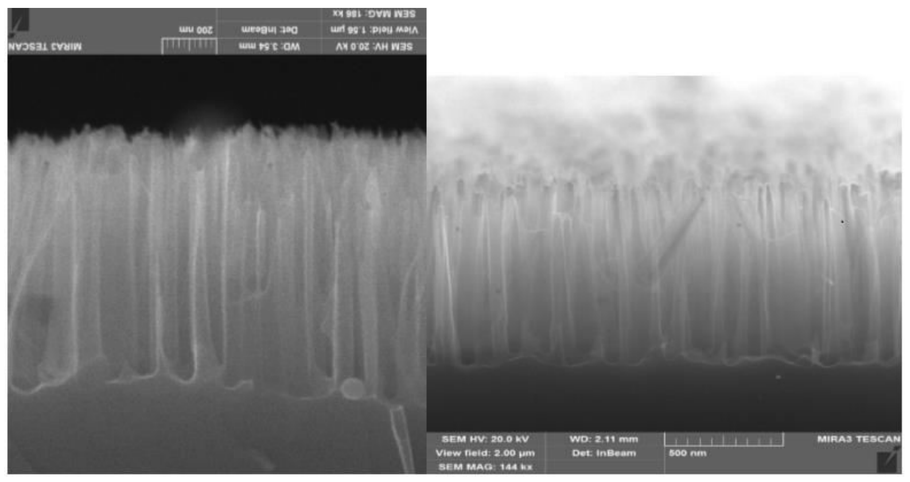

Fig2. SEM images of Si NWs with different deposition time on the first stage a) t = 30 s; b) t =60 s. The etching time at the second stage was fixed at t = 30 min and fixed flushing time at t = 30 min.

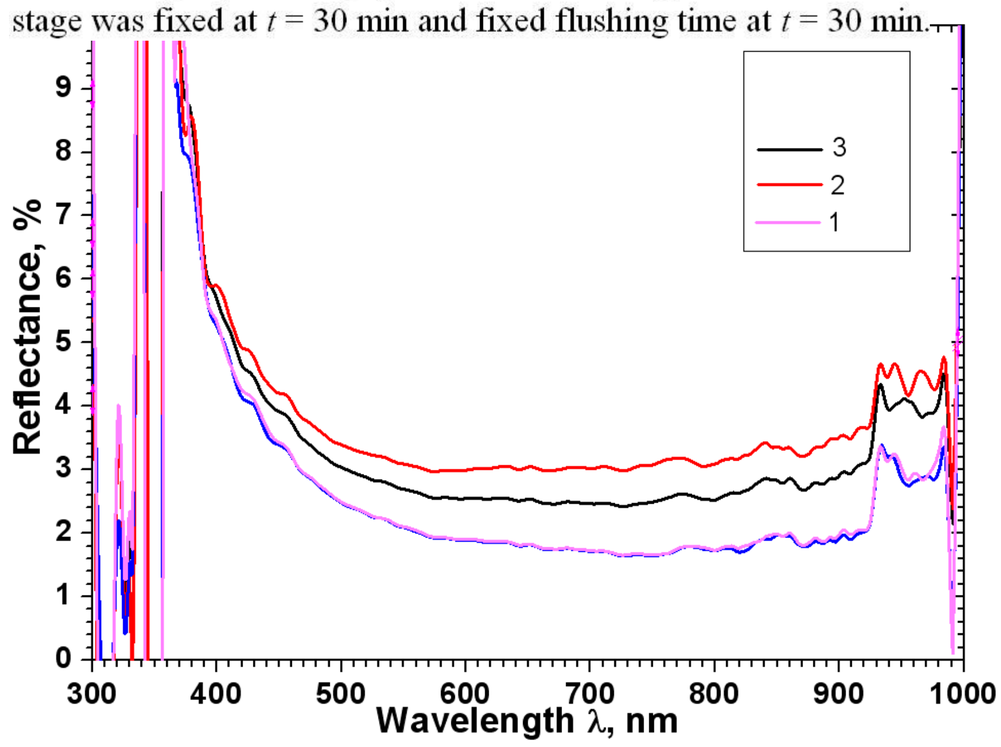

Fig. 3. The reflection spectra for SiNW with different:
1. deposition time 30 s, etching time 30 min
2. deposition time 45 s, etching time 30 min
3. deposition time 45 s, etching time 20 min