Computational Design of Photovoltaics with Silicon Nanowire

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Nonrenewable fossil fuels are burned to meet the ever-increasing demand for energy but in the process harm the environment via the emission of greenhouse gases etc. So the development of clean and renewable sources of energy is of prime importance to meet long term energy needs. The Sun is considered a renewable source of energy, but the efficiency of photovoltaic cells that convert solar energy to electrical energy is very low. Efficiency of photovoltaics can be improved by increasing the light-trapping ability of these devices. The use of a Silicon nanowire array on the Silicon substrate of photovoltaics is one suggested way of improving their efficiency. Silicon is the material of choice due to its extensive use in the semiconductor industry, natural abundance and ability to generate photocurrent. The nanowire structure on the Silicon substrate improves light trapping by improving the efficiency of carrier generation and carrier extraction.

This paper introduces two computational electromagnetic (EM) modeling tools to simulate the photovoltaics with Silicon nanowire array and compares the results from them. It will also present a justification for the requirement of a computation EM tool and discuss techniques of measuring absorption with the EM modeling tool. A simulation of the entire nanowire array would be memory intensive, so the periodic structure of the array is leveraged to obtain a unit cell with periodic boundary conditions. The unit structure is simulated from 400 to 800 THz because solar energy spectrum is from 380 to 800 nm. The simulation results are analyzed and compared to the references for accuracy.