In the present study, a design and optical analysis of periodic nanohole (NH) structure for light trapping in thin film silicon solar cell have been investigated.

The optical measurement and simulation of hexagonal array silicon NH structure on silicon wafer (1mm) has been carried out to investigate the potential of periodic NH array to reduce reflectance. The reduction of reflectance was relatively 10.4% compared to what is seen in nonpatterned silicon and it is predicted that the enhancement of absorption due to the large surface area, antireflective effect and diffraction of incoming incident light by NH array. The simulation of a hexagonal array silicon NH coated with a thin layer of indium tin oxide (ITO) shows that reflectance is greatly decreased along nearly the entire spectrum range. The design by applying periodic NH array on 1 µm thin-film silicon with silver back reflector, mimicking the real structure of solar cell was done via simulation to find the optimum parameter for highest absorption in silicon active layer. The optimized parameter of square lattice array is 0.251, 0.6 and 0.5 for filling factor, lattice constant and nanohole depth respectively. The simulation results show a relative improvement of 100 % in the total absorption for square lattice NH arrays in the silicon layer compared to nonpatterned silicon. The optimized NH arrays also exhibit a significant improvement in silicon active layer that exceeds the theoretical Yablonovitch limit in the long wavelength range. On the other hand, fabricated optimized square-lattice NH array and hexagonal NH arrays (same parameter with optimized square-lattice NH array) give relative improvements in total absorption for 65 and 70 %, respectively, compared to a nonpatterned stack. Based on the parallel-supercomputing optimization, these improvements currently represent the best experimentally measured results for 1 µm thin film silicon NH arrays with a back reflector. In addition, the effect of an ITO coating on optimized square-lattice NH array is simulated, and the results shows that an empty NH configuration gives the lowest ITO parasitic absorption of 2.6 %. An attempt of using metal nanoparticle to boost absorption in periodic NH array also has been carried out. The effect of different concentration of 20 nm diameter gold (Au) nanoparticle solution has been investigated by depositing Au nanoparticle using spin coater with velocity of 3000 rpm for 10s on NH array, in the hole of NH array and nonpatterned silicon wafer. Optical measurement shows that Au nanoparticle decreased reflectance for 28.6% and 52% compared to periodic NH array for 10 wt% could be observed for Au nanoparticle deposited on periodic NH and nonpatterned respectively. From simulation results, it could be observed that Au nanoparticle absorbed a small amount of incident light (<2.5%). Therefore low reflectance shows by measurement might be due to the high absorption in silicon.