Study and modeling of ultra-thin silicon substrates based solar cells

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Several techniques have been proposed for kerfless wafering in order to reduce silicon consumption in solar cell. Methods such as MeV hydrogen implantation and stress induced layer transfer are among the very efficient ones. However, the results obtained from cells built with such wafering techniques remain far from the reference Sanyo Heterojunction with Intrinsic Thin Layer (HIT) (24, 7 % efficiency) [1].
The objective of our work is to find by simulation with SILVACO-TCAD and PC1D softwares how to improve homojunction thin-film cells in order to optimize their efficiency. In the case of transfer by using MeV hydrogen implantation, the maximum efficiency reported yet is 14.1 % for a silicon absorber with a thickness of about 50 µm [2]. By using Silvaco-Tcad software with very appropriated parameters, mainly lifetime of minority carriers, we were able to reach an efficiency close to 16 %. We will present and compare the results from experimental and modeling. The work is in progress to optimize the simulation.

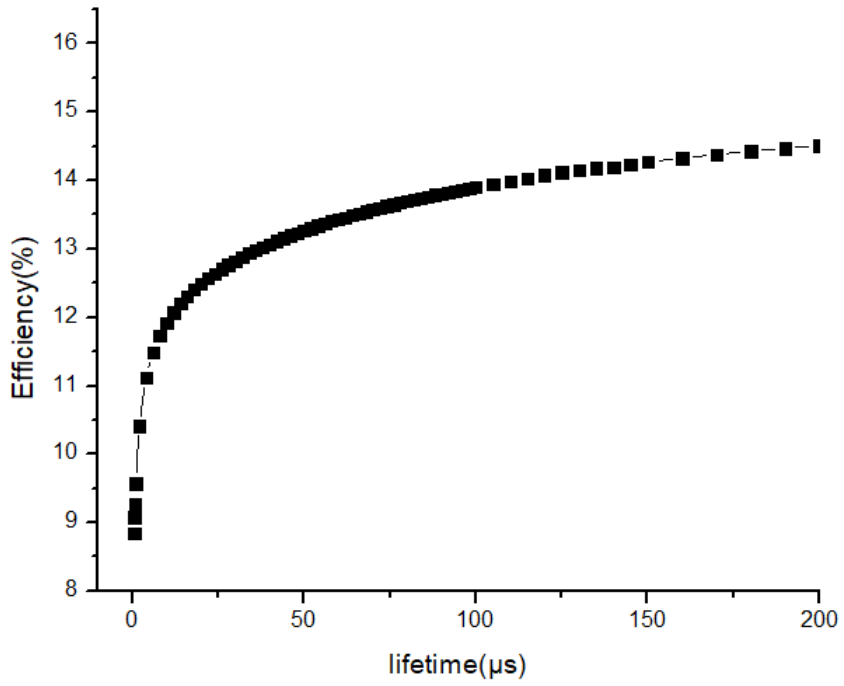

Fig: Tendency of Efficiency according to the thickness

1- M. Taguchi, A. Yano, S. Tohoda, K. Matsuyama, Y. Nakamura, T. Nishiwaki, K. Fujita, and E. Maruyama, "24.7% Record Efficiency HIT Solar Cell on Thin Silicon Wafer," IEEE Journal of Photovoltaics, vol. 4, pp. 96–99,Jan. 2014.
2- H. –S. Lee, J. Suk et al, Enhanced efficiency of crystalline Si solar cells based on kerfless-thin wafers with nanohole arrays, Scientific Reports 8:3504 (2018)