Numerical simulation and defect analysis of CIGS thinfilm solar cells using TCAD

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The solution-based Copper indium gallium selenide(CIGS) thin film solar cells has received a strong attention due to low-costproduction capability and larger volume manufacturing. However, the conversionefficiency of the CIGS thin film solar cell is relatively low compared to thatfabricated in vacuum-based process because of the many defects in CIGS thinfilms and cadmium sulfide (CdS)/CIGS interface. Therefore, it is important toreduce defects in CIGS thin film solar cells and to understand the electricalbehavior of CIGS under various defect properties.

In this work, we have modeled CIGS thin film solarcell having the energy bandgap graded light-absorbing layer by using technologycomputer aided design (TCAD) program. In order to investigate the influence ofdefects in the CIGS and CdS buffer layers on solar cell performance, the cellparameters and quantum efficiencies were numerically simulated with varying thedensity and types of defects in CIGS and CdS layers. The defects have Gaussiandistribution and were located in mid-gap states. The simulated results werecompared with experimental data.

As the simulation results, the cell performance ismore dependent on defects in the CIGS than that in CdS buffer layer. The reductionof efficiency is mainly due to the donor-type defects in the CIGS layer ratherthan acceptor-type defects. We have validated the CIGS solar cells modelingresults by comparing against TCAD simulation and experimental data. These results can improve theknowledge about defects in CIGS thin film solar cells and lead to theachievement of stable and highly efficient solar cells in the future.