INFLUENCE OF KF TREATMENT ON ELECTRONIC PROPERTIES OF CIGSSE SOLAR CELLS STUDIED BY ADMITTANCE SPECTROSCOPY

Shenghao Wang¹, Xia Hao¹, Muhammad Monirul Islam¹, Katsuhiro Akimoto¹, Takuya Kato², Hiroki Sugimoto², Takeaki Sakurai¹

¹Institute of Applied Physics, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan
²Atsugi Research Center, Solar Frontier K. K., Atsugi, Kanagawa, 243-0206, Japan

To improve the performance of copper indium gallium diselenide solar cells, post-treatment process is usually required.¹ In this work, we fabricated Cd-free-buffered Cu(In₁₋ₓGax)(SₓSe₁₋ₓ)₂ (CIGSSe) solar cells and studied the effect of post-treatment. The samples were treated under different conditions, namely, sulfur treatment (S treatment) or sulfur treatment accompanied by potassium fluoride treatment (KF+S treatment). The current density-voltage characterization shows that the device performance was improved by the post-treatment. Especially open-circuit voltage was improved from 650 mV (for no-treatment) to 680 mV (for KF+S treatment). The carrier density was increased after KF+S treatment. In this case, the minority carrier lifetime is expected to decrease. However, the time-resolved photoluminescence result shows that the minority carrier lifetime was greatly increased for the KF+S treated device as compared to the reference device (no treatment). This suggests that the recombination in KF+S treated device was significantly suppressed. We suspect the recombination in the un-treated device could be from deep level or surface/interface recombination. To verify that, we performed steady state photo-capacitance spectroscopy measurement.² No drastic difference was found for the deep level at 0.7 eV. Fortunately, we found difference in admittance spectroscopy measurement (Figure 1). The activation energy of β (generally associated with buffer layer¹) for un-treated, S treated and KF+S treated devices are 183, 160 and 120 meV, respectively. The decrease of the activation energy of β suggests that the buffer-related interface was improved in the case of post-treatment, especially KF+S treatment, resulting in improvement of surface/interface property.³ This study suggests that KF+S treatment may effectively suppress interface recombination for CIGSSe solar cells, so as to contribute to enhancing the device performance.

Figure 1: Admittance spectroscopy results for CIGSSe solar cells (a) without post-treatment, (b) with S treatment and (c) with KF+S treatment.

References