Electronic Supplementary Information

A simple chemical route for composition graded $Cu(In,Ga)S_2$ thin film solar cells: multi-stage paste coating

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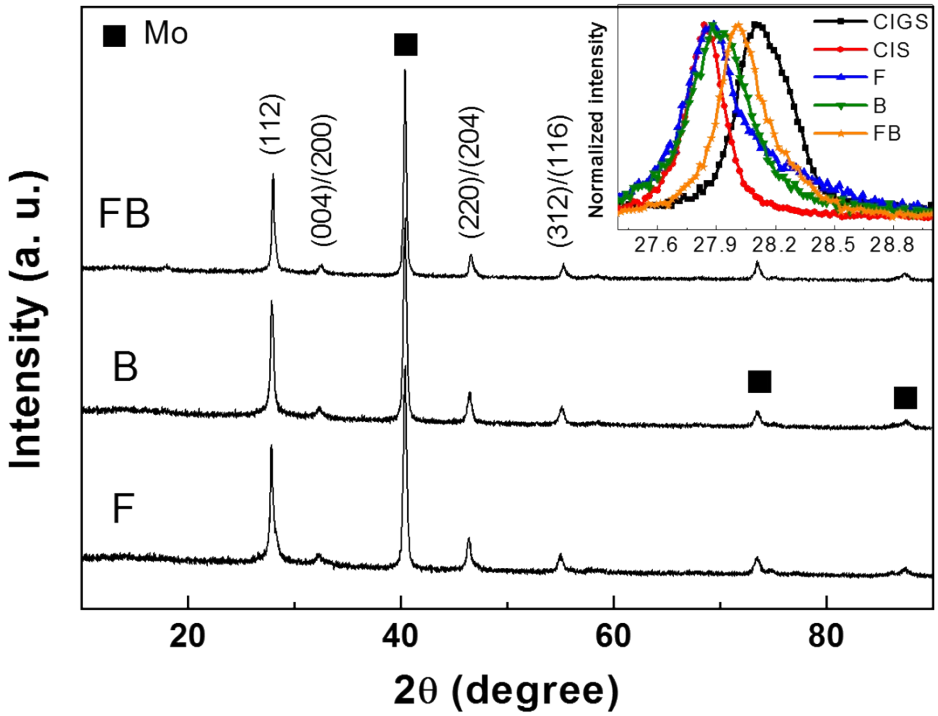

Fig. S1 XRD patterns of the trilayered thin films with three different stacking configurations. The inset of Fig. S1 shows the peaks of (112) phase at the slightly different 2θ even though that of the CIS film is in good agreement with a Joint Committee on Powder Diffraction Standards reference (JCPDS #27-0159). By adding the Ga-included layer, the peaks shifted toward higher angle, which is attributed to the decrease of unit cell lattice parameter along with Ga incorporation. Note that the film F and B prepared by the same amount of Ga-included layer showed the peak at the same position implying that there is correlation between Ga contents and 2θ values.

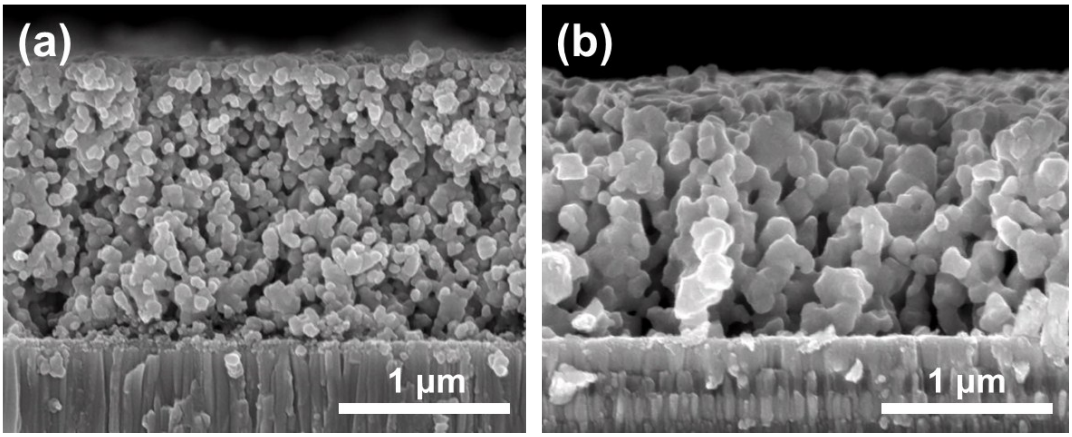

Fig. S2 Crosse-sectional SEM image of the CIGS film prepared by only paste A (a) and the CIS film prepared by only paste B (b)

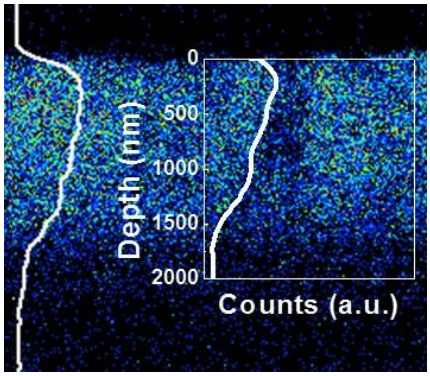

Fig. S3 Ga composition profile (EPMA and AES (inset)) of a CIGS film synthesized by paste A only showing self-Ga grading profile

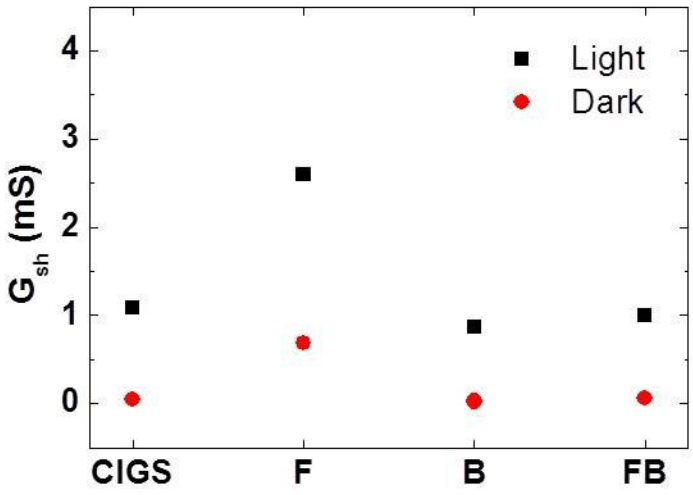

Fig. S4 Shunt conductance of the trilayered cells (non-graded and front, back, and double gradient) measured under dark and light conditions

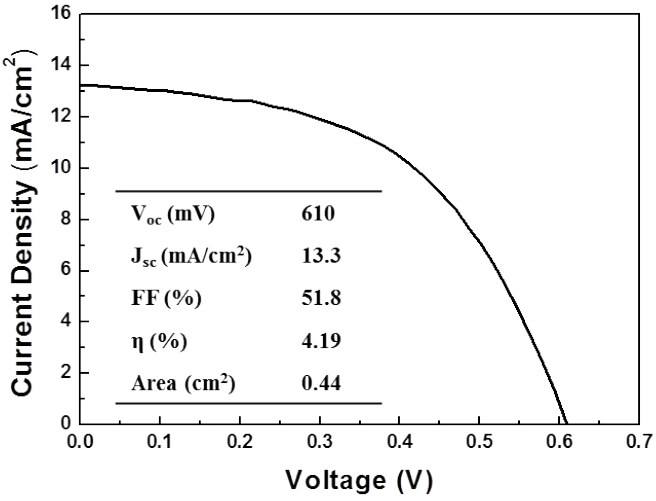

Fig. S5 *J-V* characteristics of the CIGS thin film solar cell device with the trilayered non-graded absorber film prepared by only paste A