Self-aligned growth of thin film Cu(In,Ga)Se_2 solar cells on various micropatterns

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We provide the first demonstration of a self-aligned growth of thin film Cu(In,Ga)Se_2 solar cells and microcells. We created Cu(In,Ga)Se_2 solar cells by direct localized electrodeposition and annealing on two patterns : lines of 1105 µm and 105 µm width and 1 cm long. We obtained up to 7.6% efficiency on the 1105 µm wide lines and 5.3% efficiency on 105 µm wide lines. This work demonstrates the possibility to directly grow efficient solar cells on tunable patterns, with very efficient material usage. This is important in the perspective of thin film micro-concentrators and also semi-transparent photovoltaic windows for building integrated applications

The electrodeposition technique, used to selectively deposit metals, is very efficient in terms of material usage. This technique has indeed a very high material utilization rate, over 90%, because solutions can be regenerated and no parasitic deposition occurs. This is very interesting in order to develop photovoltaic solutions with the smallest impact possible on natural resources.

The characterization shows much improvements can be expected from process optimization, especially on the annealing step, to reduce the bulk concentration defects and thus improve the efficiency.

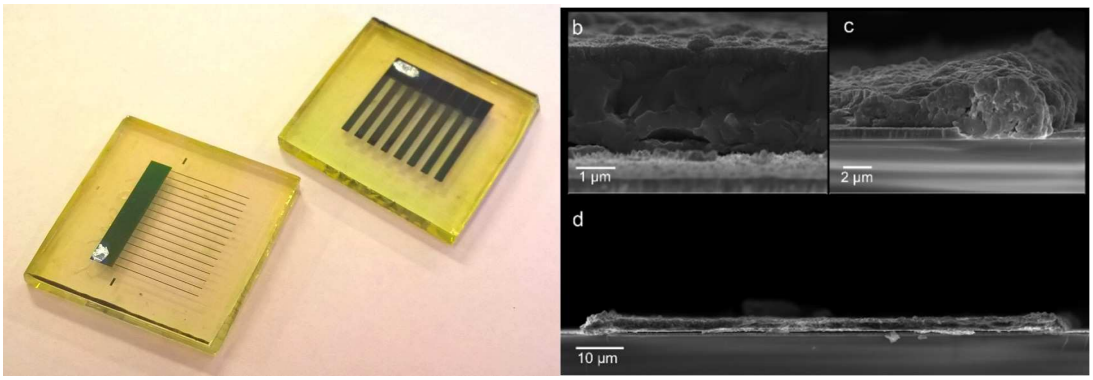

FIG 1: a) Image of the devices with fingers of 105 µm (left) and 1105 µm (right). The glass samples are 25x25 mm². b), c), d) SEM images of the cross section of the 105 µm sample. d) is the full view of the finger, c) a zoom in the center of the finger, d) a view of the edge.

Table I : Opto-electronic parameters of the record devices. Jsc, Voc, FF and efficiency are calculated from AM1.5G measurements. Ideality factor n and saturation current density J_{02}, parallel resistance Rp and series resistance Rs are deduced from dark IV measurements.

	J_{sc} (mA/cm²)	V_{oc} (mV)	FF (%)	η (%)	Width (µm)	Area (cm²)	Ideality n	J_{02} (mA/cm²)	R_p (ohm.cm²)	R_s (ohm.cm²)
1105 um	30.3	449	56.1	7.64	1105	0.105	2	2.3 E-3	3252	3.5
105 um	30.2	368	48.3	5.38	105	0.01	2	1.5 E-2	932	2.0