

Free form metallization of solar cells using Laser Induced Forward Transfer

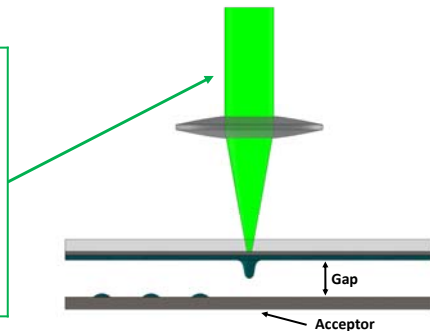
D. Munoz-Martin, Y. Chen, D. Canteli, M. Morales, C. Molpeceres
Centro Láser – Universidad Politécnica de Madrid, Alan Turing 1, Madrid, 28038, Spain
Contact: david.munoz@upm.es

Aim of the work

- Front metallization is an expensive, fundamental step in the fabrication of solar cells
- Laser additive direct writing techniques, such as Laser Induced Forward Transfer (LIFT), can be used for printing optimized metallization patterns or free form personalized designs with applications in building integrated photovoltaics (BIPV).

LIFT and experimental setup

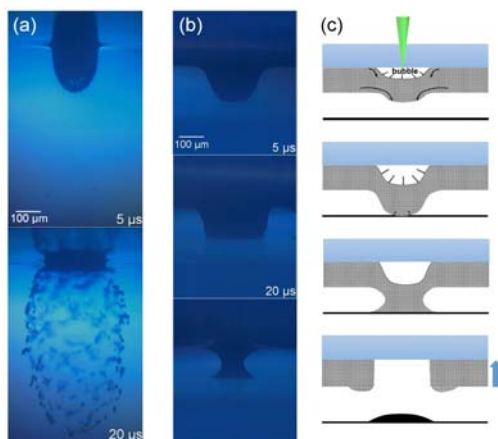
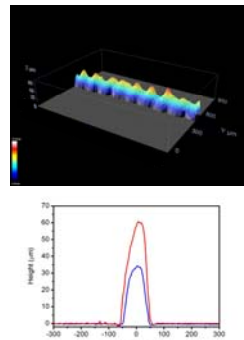
Laser source	Spectra Physics Explorer ▪ 15 ns ▪ 532 nm ▪ $E_p < 40 \mu\text{J}$	EKSPLA Atlantic ▪ 13 ps ▪ 532 nm ▪ $E_p < 85 \mu\text{J}$
Optical path	<ul style="list-style-type: none"> ▪ Optical Scanner (ScanLab HurryScan) ▪ F-Theta Lens, focal 250 mm ▪ Focused beam diameter $\sim 20 \mu\text{m}$ 	



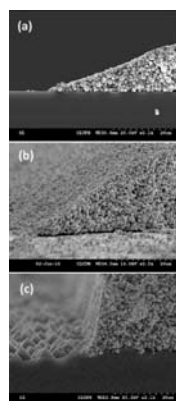
- Donor film:
- Comercial Ag paste (Dupont PV17F & PV19B)
 - Non-newtonian, pseudoplastic, thixotropic fluids
 - μ up to 250 Pa-s
 - Ag particles size: 1-5 μm

Printing of solar cell fingers

- Continuous lines (fingers) printed by overlapping single voxels.
- Aspect ratios (height/width) up to 0.5.
- Transfer mechanism: Concrete-dot transfer regime.
- Highly textured surfaces provide high adhesion forces and prevent the paste from spreading along the surface.

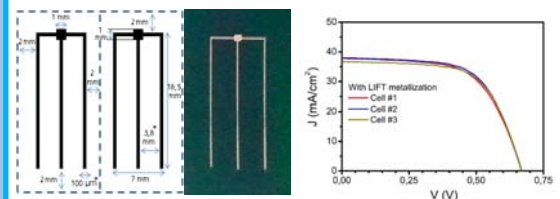


D. Munoz-Martin et al. Applied Surface Science 366, 389–396 (2016)



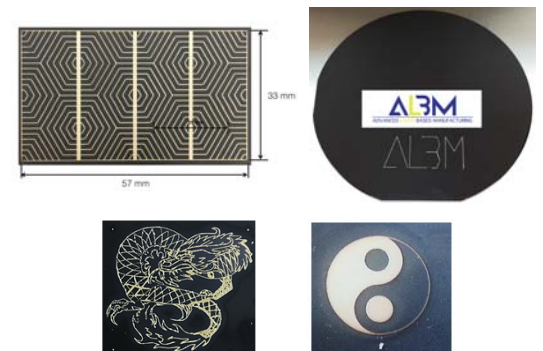
Y. Chen et al. Results in Physics 6, 998-999 (2016)

Metallization of a CIGS solar cell



- 2 cm² lab test cells of CIGS on a flexible steel substrate.
- Low electrical resistivity and good mechanical adherence to the substrate
- Fingers thermally cured. Possibility of laser curing (all-laser based metallization process)

Free form metallization



Conclusions

- ✓ The physics of LIFT of high viscosity fluids has been studied. High aspect ratio lines (~ 0.5) can be printed.
- ✓ Flexible CIGS solar cells have been metallized showing appropriate functionality.
- ✓ The main advantage of LIFT for the metallization of solar cell over the standard techniques is its flexibility and feasibility of printing free-form, personalized designs for BIPV.

ACKNOWLEDGEMENTS

This work has been supported by the European Commission APPOLO project (FP7-2013-NMP-ICT-FOF. 609355) and the Spanish MINECO SIMLASPV-MET (ENE2014-58454-R), HELLO (ENE2013-48629-C4-3-R), and CHENOC (ENE2016-78933-C4-4-R).