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Project »Rock-Star« – High-Speed Rotary Printing for Solar Cell Metallization: From Vision to Reality

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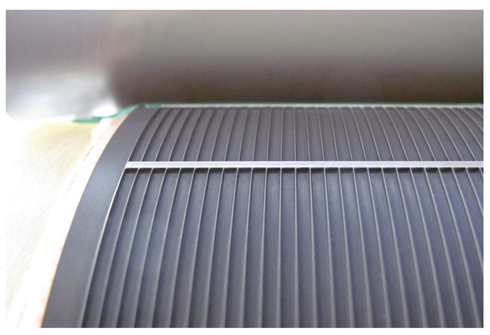
Background and Motivation

- Increasing gross throughput rate by factor 2 (8000 Wafer/h per line) compared to flatbed screen printing
- Continuous printing process instead of stop-and-go process
- Usage of low-cost printing forms
- Efficient silver consumption due to reduced paste laydown
- Development of a demonstrator machine with high technology readiness level (TRL)[1]



Flexographic printing form with ultra fine line layout for front side metallization

Joint Project »Rock-Star«

- 7 Industry partners
- Project period: Sept. 2015 – December 2019
- Supported by the German Ministry of Education and Research (BMBF)

Project Aims:

- Evaluation rotary printing
- Development of demonstrator
- Fabrication of highly efficient solar cells

Project partners:

ASYS SOLAR, gallus, Continental, Fraunhofer ISE, idd printing science technology

Associated partners:

ZECHER, Q CELLS a Hanwha company

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Bundesministerium für Wirtschaft und Energie
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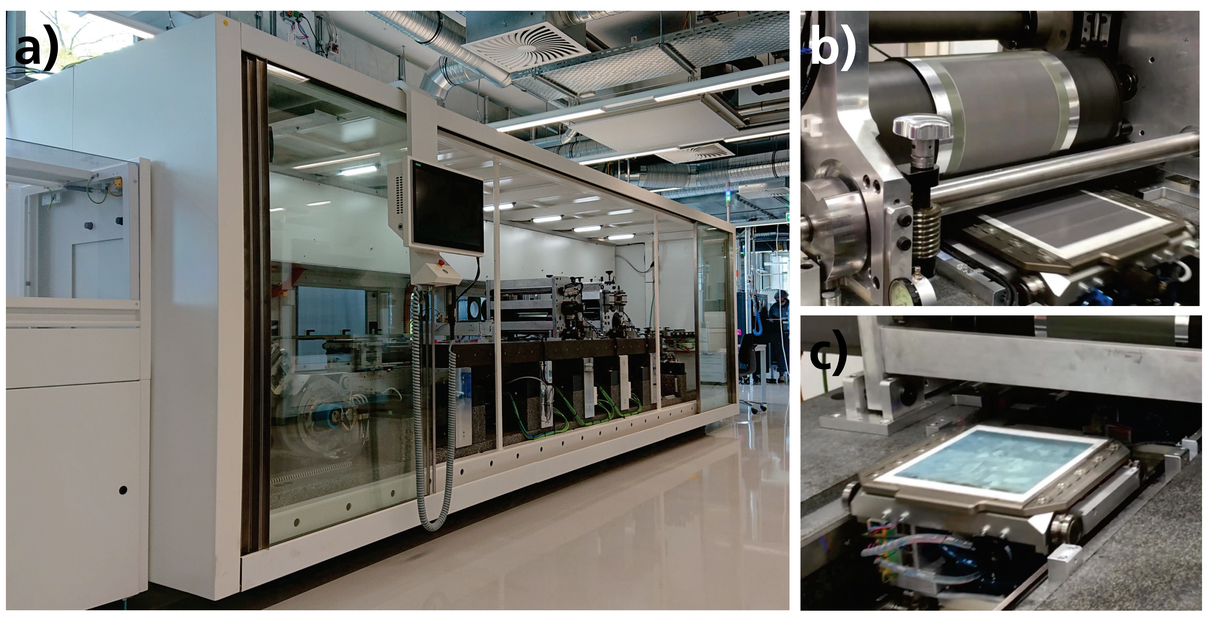
»Rock-Star« Rotary Printing Demonstrator

- Demonstrator machine for high-throughput metallization of Silicon solar cells and electronic devices
- Special features:
  - Innovative shuttle transport concept with autonomous energy supply, vacuum system
  - High-speed camera positioning system
  - Flexo printing unit (front side metallization)
  - Rotary screen printing unit (rear side metallizaton)
  - Cycle time down to < 0.5 s per cell
- Fields of application:
  - Solar cell front and rear side metallization (PERC, HJT, TOPCon)
  - Electronic devices (PCB, fuel cell, power electronic devices etc.)
  - Application of functional inks/pastes



»Rock-Star« Rotary printing demonstrator device (a), rotary screen printing unit (b) shuttle transport of a PERC solar cell through the printing units (c)

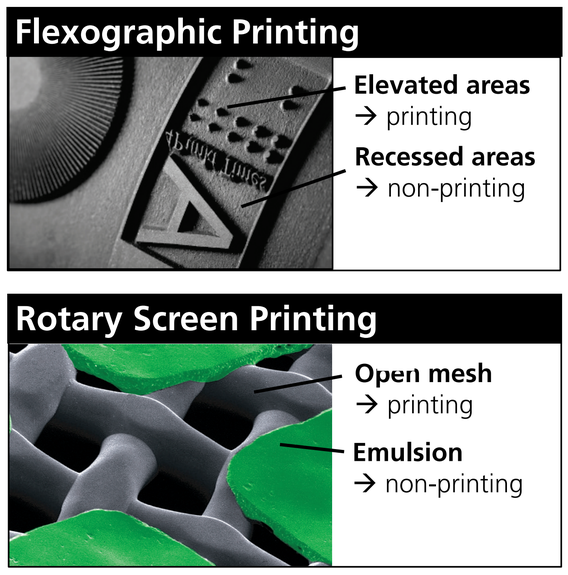
Rotary Screen and Flexographic Printing

Flexographic Printing:

- Flexible printing plate/sleeve
- Fine lines down to w_n = 5 µm on printing form[2]
- Printed contact finger width down to $w_f \approx 30$ µm[3]

Rotary Screen Printing:

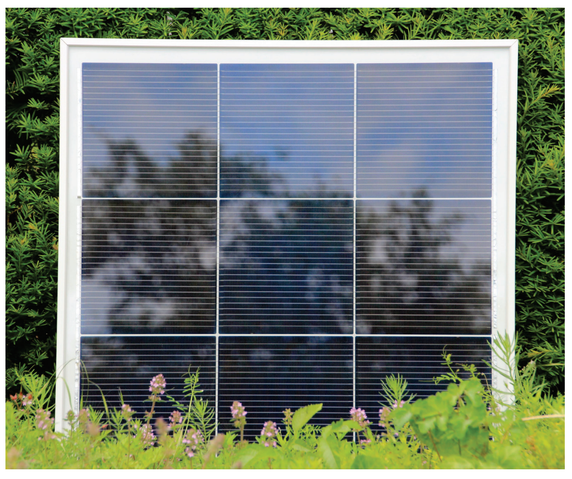
- Cylindric, rotating screen
- Commercial metallization pastes (slightly modified)
- Front and rear side metallization of PERC solar cells successfully demonstrated[3]



Working principle of flexography and rotary screen printing method.

Major results of Project »Rock-Star«

- Development of »Rock-Star« demonstrator machine
- Over1000 Al BSF and PERC solar cells metallized using flexography and rotary screen printing[3]
- Feasibility of rotary printed metallizaton demonstrated on cell and module level:
  - mc-Si PERC solar cells η_{max} = 19.7 % ($\eta_{\varnothing}$ = 19.3 %)
  - 9-cell demonstrator modules with SmartWire (SWCT)[4] interconnection



9-cell demonstrator module with partly rotary screen printed mc-Si PERC solar cells and SmartWire interconnection

[1] Mankins, White Paper (1995)
[2] Lorenz et al., J. Sol. Energ. Mat. 157 (2016)
[3] Lorenz , PhD Thesis (2018)
[4] Söderström et al., Proc. 28th EUPVSEC (2013)

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