Technical Facts and Details

Since the idea was born in 2016 and first tests with a simple hollow glass cylinder were promising, FlexTrail has developed rapidly and has become well-elaborated up to now. In fact, many possibilities for a one-capillary print head are available today, ready to be integrated, e.g., into a commercial inkjet printer or into a high-precision versatile robotic arm. Key technical facts of FlexTrail printing are listed here:

- production-scale printing speed of up to 500 mm/s
- high tolerance towards a wide variety of rheological fluid properties, especially viscosity
- extremely small dead volumes and fluid consumption in the µL range
- printed functional lines with minimum feature sizes below 5 µm possible
- glass capillary allows printing of metal inks, pyrophoric fluids, etching media, etc.
- printing on hot substrates possible
- tolerance towards substrate thickness variations
- printing on curved/complex 3D-contoured surfaces
- one-capillary print head available
- parallelization concepts exist
- compatibility with pre- and posttreatments like plasma pretreatment or intense pulsed light annealing

For further information

Inkjet- and FlexTrail-Printing with Low Silver Consumption for Silicon Heterojunction Solar Cells

Advanced Metallization with Low Silver Consumption for Silicon Heterojunction Solar Cells

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FlexTrail Printing

A Novel Printing Technique

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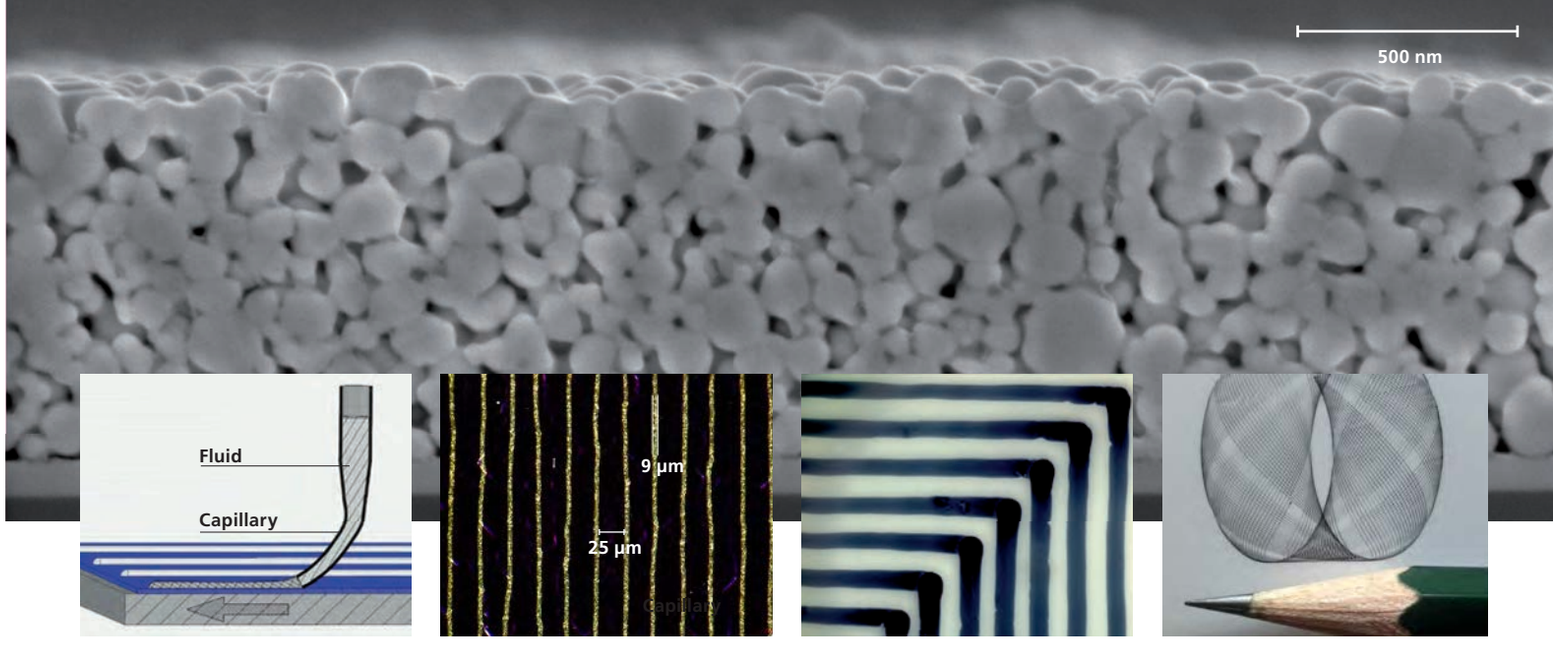
A Novel Printing Technique

FlexTrail printing is a novel and innovative printing technique invented and developed at Fraunhofer ISE. It's impressive as it allows printing of ultra-fine (functional) lines exhibiting minimum feature sizes of 5 µm and 10 µm on planar and textured surfaces, respectively.

Our Offer

- direct metallization of solar cells
  - printing of metal nano-particle fluids
  - feature sizes smaller than 10 µm on textured surfaces
  - large silver saving potential compared to screen printing process
  - printing of tapered metal contacts
  - process transfer to printed electronics possible, e.g., PCBs
- printing of etchants
  - etching of metal layers
  - printing of etchants with a wide pH range, corrosive materials possible
- printing of oligomeric polysilanes and organic polysilazanes
  - formation of silicon layers
  - defect-free passivating layers
  - precision and process stability
- graphical printing
  - printing of ultra-fine curved lines
  - complex security features
  - high resolution and reliability



Background: Cross-sectional view of a nano-silver contact finger (scanning electron micrograph) printed with FlexTrail; From left to right: Schematic drawing of FlexTrail setup; parallel-printed nano-silver contacts with ultra-fine pitch; angled FlexTrail-printed lines; lissajous curve printed using FlexTrail.

The printing speed reaches up to 500 mm/s, which underlines FlexTrail's industrial processing potential. Besides printing straight, micrometer-sized lines with extremely fine pitch, FlexTrail can also print curved structures and can even print on curved surfaces.

FlexTrail was initially developed for the direct metallization of solar cells. Meanwhile due to its robustness, its field of application has expanded to etching and structuring processes or printing of pyrophoric fluids, for example. Thus, FlexTrail is taking its place in the ranks of established printing techniques.

Flexible Trailing – FlexTrail

A thin and flexible glass capillary filled with a fluid is the heart of the FlexTrail print head. A unique selling point of this printing technique is its tolerance towards rheological properties of the printing medium. Low-viscous inks for inkjet printing but also high-viscous pastes for screen printing can be processed. FlexTrail exclusively fills the "viscosity gap" existing between pastes and inks.

During printing, the glass capillary has contact with the substrate and continuously trails over it. Thereby, the fluid's wetting behavior is the driving force for reliable fluid deposition. This is supported by applying a very low atmospheric pressure at the capillary's upper end. This ensures proper start/stop behavior and reliable printing. The glass capillary's flexibility and bendability allow for non-destructive processing and balances out possible substrate waviness.

As Europe's largest solar energy research institute, the focus of FlexTrail applications at Fraunhofer ISE has been in photovoltaics up to now. However, there are many other possible applications for FlexTrail in other fields, for example, in printed electronics, printing of organic cells, or graphical printing. We are continuously looking for partners to realize new ideas with.