Ink-jet printed Optical Taper Structures for Planar Optronic Systems

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PlanOS

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Framework

Optical waveguides on flexible PMMA foil are created by flexographic printing for planar optronic systems.

- Typical Dimensions:
  - Width: 200 µm
  - Height: 100 µm
- Substrates:
  PVC and PMMA foil
- Waveguide material:
  Acrylates with suitable refractive index.

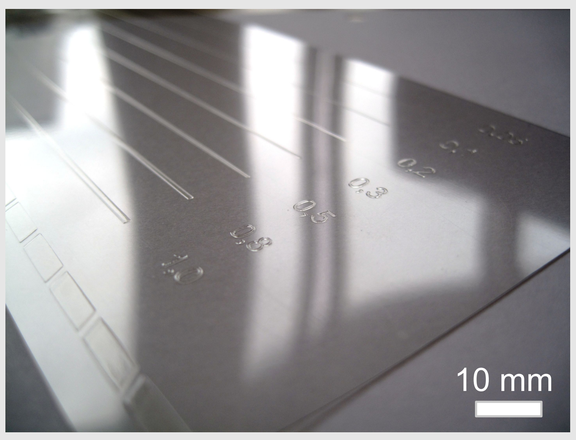


Figure 1: Flexographically printed optical waveguides (T. Wolfer, ITA)

Light Sources for Planar Optronic Systems

Different options to couple light:

- Facet coupling (free beam or fiber)
- Light emitting area (OLED, Fluorescence)
- **Chip-based light sources on foil**

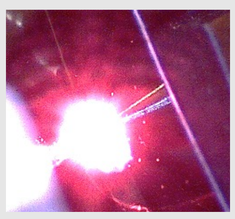


Figure 2: Laser Diode

Pro:

- High Power density.
- Good reliability and lifetime.

Contra:

- Requires electrical current.
- Complex integration (mechanical, electrical, optical).
- Diode heats up and stops lasing.
- Are not compatible with Flexographic Printing, require contact free material deposition method of tapers.
- Suitable technology: **Ink-jet printing.**

Theoretical Considerations

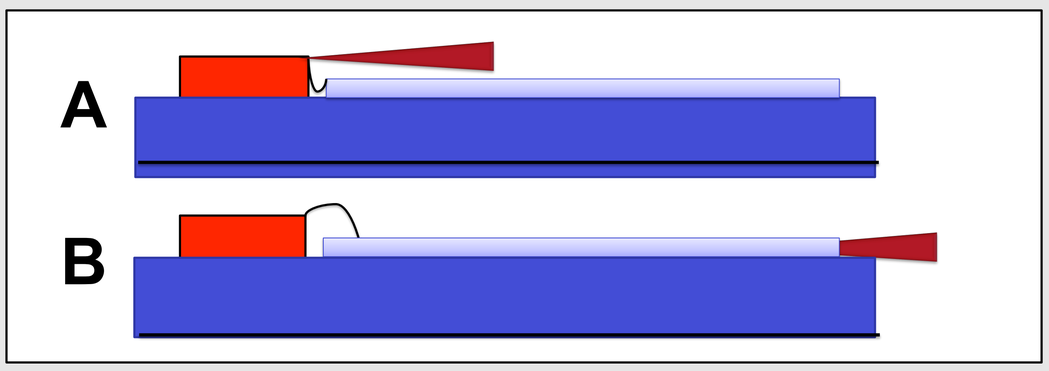


Figure 3: Schematic Diode Taper

- Structure **A** causes light to go past the waveguide.
- Structure **B** catches light emitted by the diode and guides it into the waveguide.
  - Deposition of large volume required.
  - Ink pinning prevents ink from minimizing surface energy.
  - Necessary to achieve such elevated structures.
  - Current method to induce ink-pinning: Heated substrate.
- Refractive index: As high as possible.
- Stray light absorbed by coating on the substrate.

Experimental Results and Discussion

Two inks available: Ink Epo, UGS70E.

- Ink Epo: Commercial ink with volatile agent as viscosity modifier.
- UGS70E: In-House development, no volatile agents.

Diode:

- Roitner CHIP 650ps
- Edge emitting (650 nm)
- Power: 5 mW

Printing Parameters:

- Dimatix DMP 2831
- T_{ink}: 50° C
- T_{foil}: 75° C

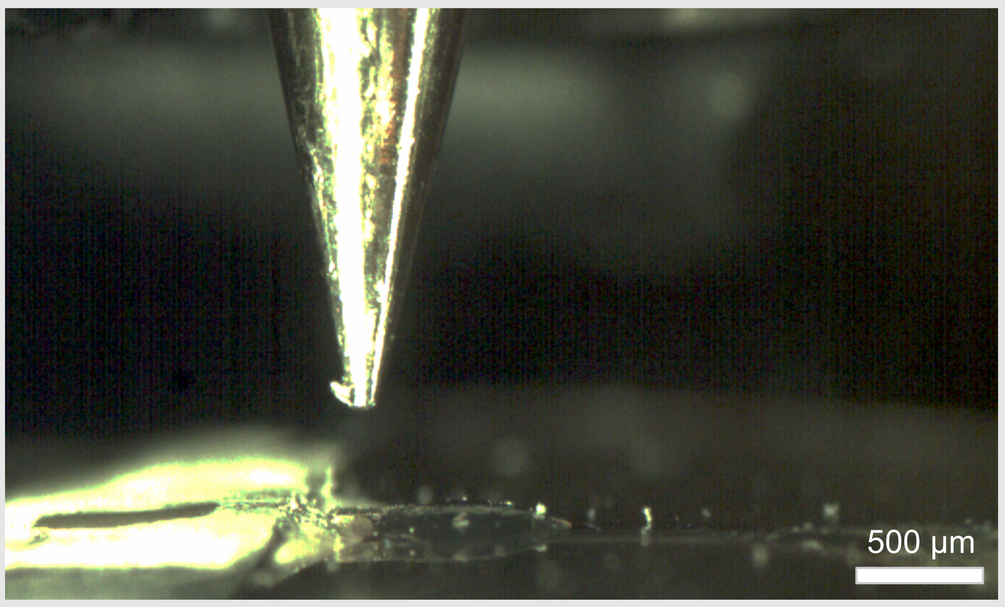
Print Pattern:

- 25 x 25 Droplets
- 25 Layers
- Deposited volume: about 0.25 µl

Figure 4: Taper Demonstrator

Current Problems:

- Wetting difficult to control
- Ink creeping along edges
- Low sample yield



Electrical contact | Diode | Printed Taper | Flexo-printed waveguide

Figure 5: Microscope view of printed taper structure

Conclusion and Outlook

- Ink-jet printed tapers demonstrated successfully.
- Process not yet reliable, difficult to control ink behaviour.

Possible solutions:

- Anisotropic surface treatment (localized microplasma).
- Wax printing to prevent wetting.
- Printing on cold substrates.
- Immediate UV-polymerization.
- Simulation tools like topology optimization for custom deposition of droplets.

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