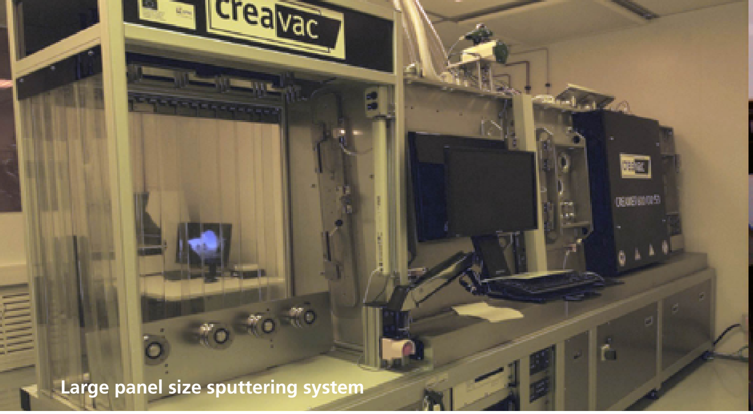
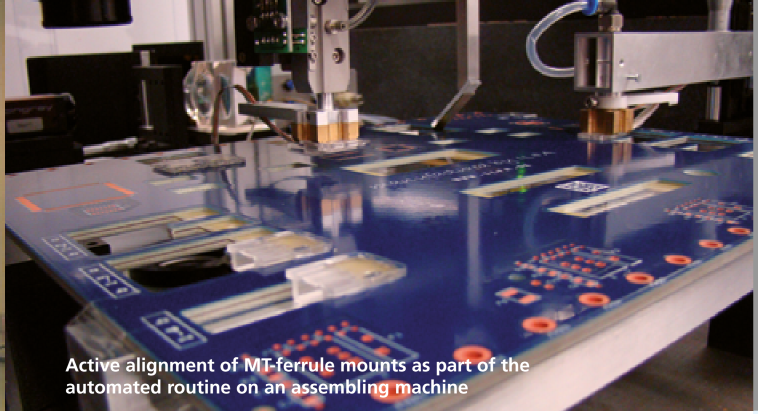


Large panel size sputtering system


Active alignment of MT-ferrule mounts as part of the automated routine on an assembling machine

SIMULATION

Process Simulation - Waveguides

COMSOL Multiphysics®:

- FEM simulation of the ion-exchange process for virtual prototyping of waveguide manufacturing

Optical Simulation - Waveguides

Lumerical®:

- EME, FDTD, BPM and FEM simulation for virtual characterization of waveguides and other optical structures

FABRICATION EQUIPMENT

Complete equipment for panel size up to 610 x 457 mm^2

Sputtering of metal coatings

- CREAVAC - CREAMET 600 CL2 S3
- Flexible material variation due to three simultaneously installed targets

Photoresist dip-coater

- ahk Compact-Dip
- Positive and negative photoresist (HTP)

Laser direct imaging system

- Schmoll MDI (3 µm line-space)

Molten salt furnace for ion exchange

- Flexible multi bath system

Laser system for glass cutting and structuring

- MDI - LD600-H
- Hybrid laser machine (532 nm and 10.6 µm)

MEASUREMENT SYSTEMS

Refractive index

- Near field refractometer
  - 1D and 2D profiles of refractive index
  - Measurement wavelength: 678 nm
  - n = 1.42 – 1.62, Resolution: 10^{-4}
- Prism coupler
  - Abbe refractometer and m-line spectroscope
  - n = 1.0 – 2.1, Resolution: 10^{-4}
  - Measurement wavelengths: 633, 830, 1,550 nm
  - Layer thickness measurement (inverse WKB)

Optical losses

- Insertion, coupling and propagation losses
- Measurement wavelengths: 600 – 1,550 nm

Mode field diameter

- Beam Profiling System using IR-Camera
- Transversal offset method

Optical backscattering in waveguides

- Optical frequency domain reflectometer
- Measurement wavelength: 1,525 – 1,610 nm
- 70 µm sampling resolution
- Backscatter-level sensitivity: -130 dB

General characterization

- Keyence VHX 6000 – light microscope: 2D & 3D visualization
- Olympus LEXT OLS4000 – laser measuring microscope: 3D nano meter level imaging

CONTACT

Fraunhofer Institute for Reliability and Microintegration IZM
Gustav-Meyer-Allee 25
13355 Berlin, Germany
www.izm.fraunhofer.de

Dr. Henning Schröder
Phone: +49 30 46403-277
henning.schroeder@izm.fraunhofer.de

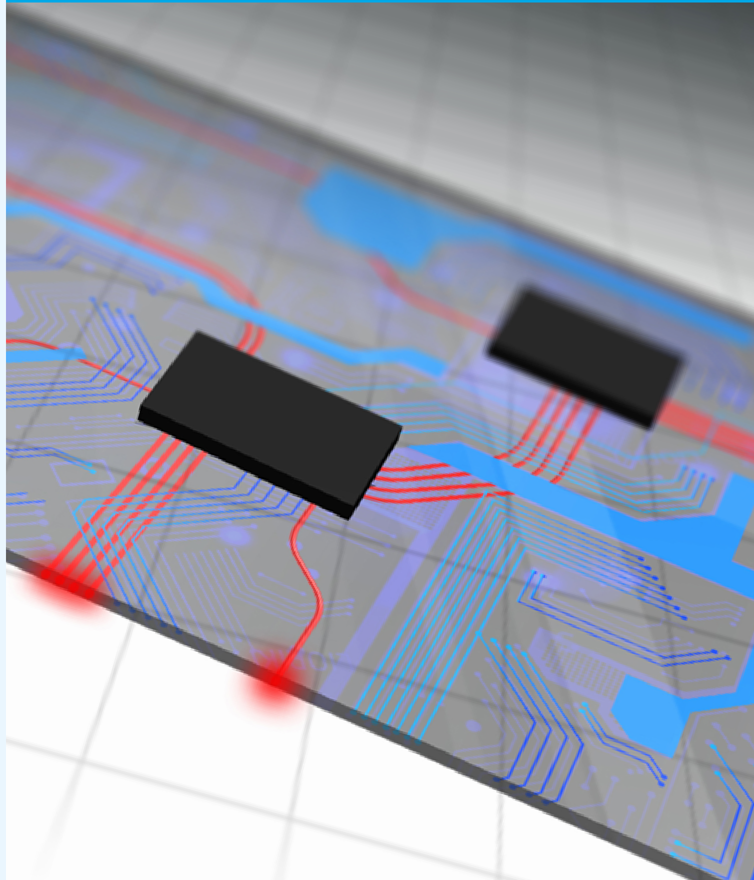
Julian Schwietering
Phone: +49 30 46403-731
julian.schwietering@izm.fraunhofer.de

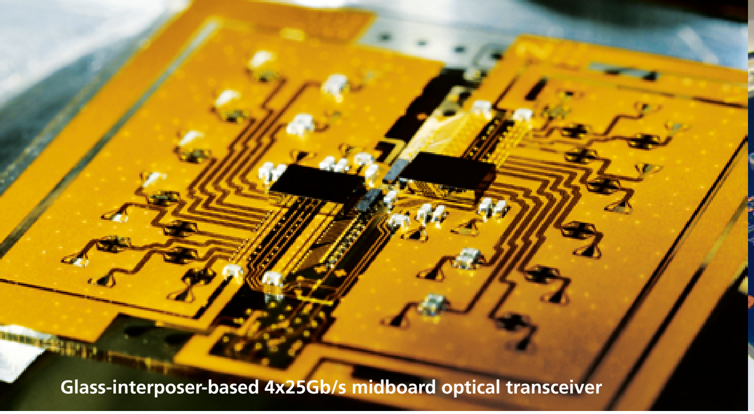
Further information:
https://www.izm.fraunhofer.de/EOCB

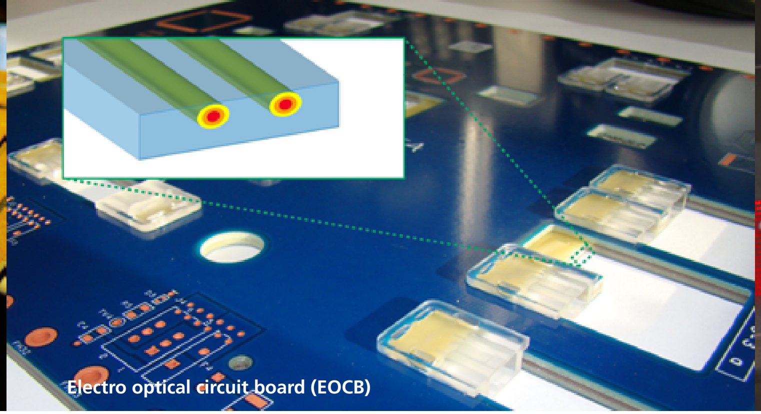
Fraunhofer
IZM

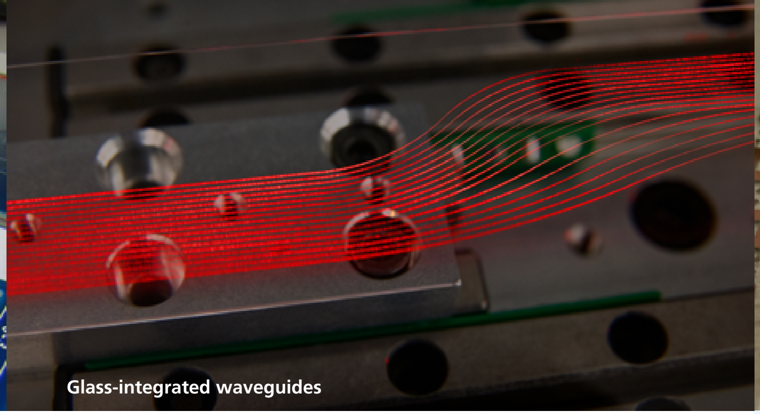
FRAUNHOFER INSTITUTE FOR
RELIABILITY AND MICROINTEGRATION IZM

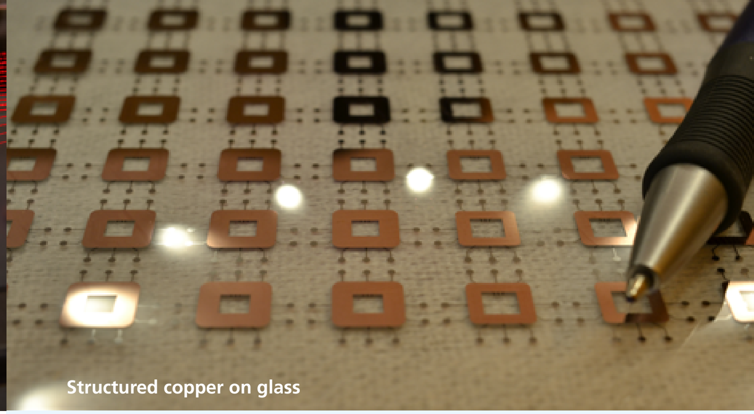
ELECTRO-OPTICAL CIRCUIT BOARD (EOCB)




Glass-interposer-based 4x25Gb/s midboard optical transceiver


Electro optical circuit board (EOCB)


Glass-integrated waveguides


Structured copper on glass

APPLICATIONS

Embedded optical interconnects offer superior bandwidth-distance products compared to electrical copper lines in PCB. They are therefore a prime candidate for data communication networks inside:

- High performance computers
- Storage servers
- Core routers
- Next generation consumer devices

In combination with wavelength division multiplexing, the data channel density of optical interconnects can be orders of magnitude higher than electrical links.

For board-to-board or even chip-to-chip optical interconnects, electro-optical circuit boards (EOCB) are needed to enable compact and power efficient future data communication systems.

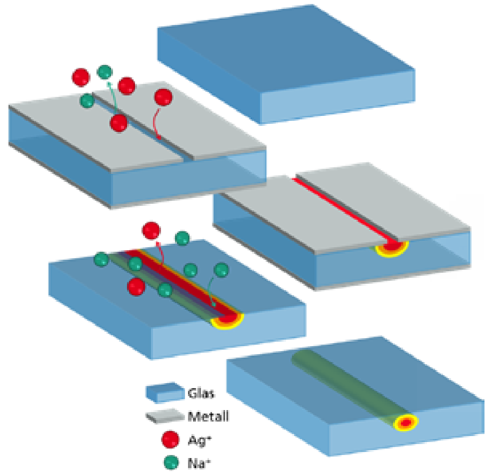
EOCB comprise:

- Single or multi-mode optical waveguides
- Embedding of optical interconnect layers in a printed circuit board
- Pluggable optical coupling interfaces
- Electro-optical interposer for on-board transceivers
- Electrical high frequency circuits on top of the glass
- Sensor applications (Lab on a chip)

EOCB BY FRAUNHOFER IZM

Waveguides in glass

The integration of waveguides in glass uses a two step ion-exchange technology:
First, a metal layer is deposited on the glass and structured via photolithography using laser direct imaging. The masked glass is dipped into a molten salt containing silver ions which create a gradient index profile. After removing the mask, a reverse ion-exchange buries the waveguides inside the glass. These gradient index waveguides show low propagation losses on a wide wavelength spectrum and low coupling losses to optical fibers. With a CO_2-laser, the glass is cut to the desired size and cavities or optical interfaces are created.



Optical components

Optical components like splitter, combiner and others can be realized. Evanescent field coupling can be used for both in-plane coupling and out-of-plane coupling.

Structuring and cutting of glass

Contactless glass processing, such as cutting, drilling and free shape structuring is carried out using a hybrid laser machine (532 nm and 10.6 µm). High precision can be achieved by camera supported alignment.

Metallization of glass

Metallization of glass can be used for electrical circuits, heating elements, mirrors, alignment marks and further applications. We are able to deposit Al, Cr, Cu, Ti and WTi using a sputtering system. Galvanic processes additionally enable Ag, Au, Cu and Ni layers on top of a seed layer. All layers can be structured via photolithography down to less than 3 µm line-space.

Electrical vias

The combination of drilling holes in glass with a laser and the metallization can be used for electrical or thermal vias.

Soldering on glass

To solder electrical components on glass, solderable metals can be deposited on glass enabling further functionalization.

TECHNICAL DATA

Glass waveguide panels

- Glass: Schott D 263® T eco (others on request)
- Panel size: 440 x 305 mm^2
- Thickness: 300 – 550 µm

Waveguide specifications

- Gradient index waveguides
- Low dispersion
- Buried waveguides
- Single-mode or multi-mode
- Propagation loss below 0.1 dB/cm (λ = 850, 1,310 & 1,550 nm)

Laser cutting and structuring of glass

- Borosilicate glass, soda-lime glass (others on request)
- Glass size: up to 610 x 610 mm^2
- Laser cutting of optical glass edge quality with high edge strength
- Laser structuring:
  - Smallest structure size: 100 µm
  - Structuring accuracy: ≤ 20 µm

Metallization of glass

- Sputtering: Al, Cr, Cu, Ti, WTi
- Galvanic processes: Ag, Au, Cu, Ni
- Glass size: up to 610 x 610 mm^2
- Photolithographic structuring
- Line-space: down to 3 µm