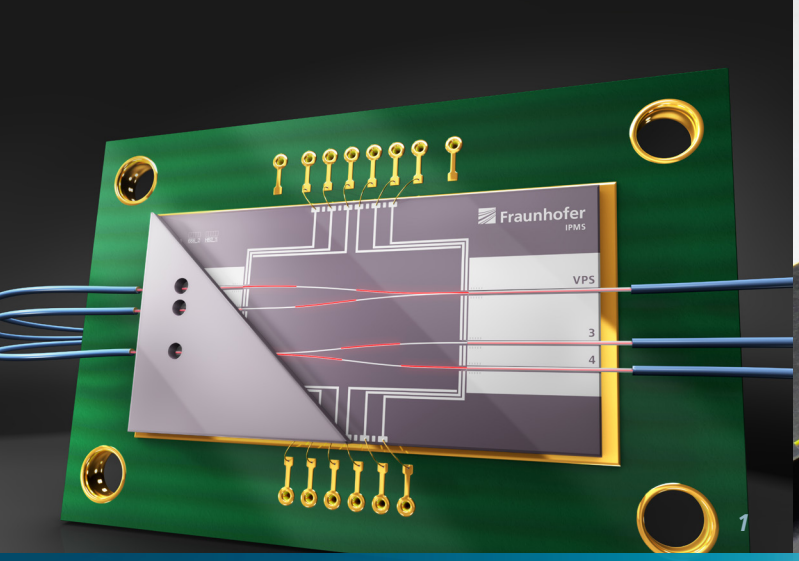

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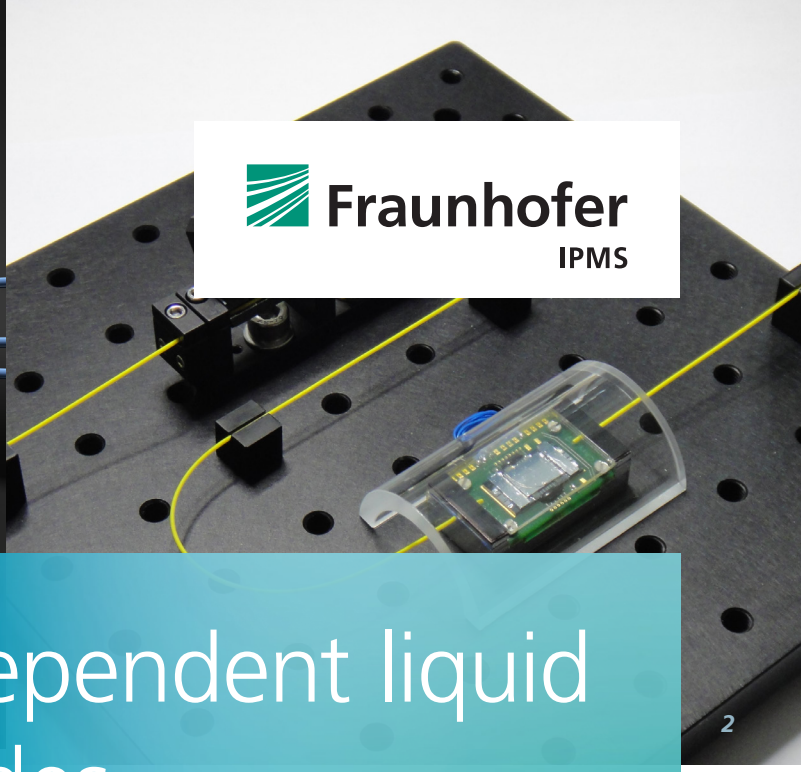

2

Fraunhofer IPMS

Polarization independent liquid crystal waveguides

Many applications nowadays are sensitive to light polarization and require polarization maintaining components. Likewise, there are applications which demand polarization independent components, for instance when it is important to reduce the complexity of fiber optic networks and costs.

Fraunhofer IPMS electro-optically induced waveguides technology with liquid crystals on silicon backplane is attractive for optical switching applications. Key features stem from employing highly transparent liquid crystal blends as waveguide core materials. In particular, the optical power transmitted along the waveguide structure can be controlled by adjusting the electro-optical Kerr response strength in a liquid crystal layer on a sub-microsecond timescale with an applied electrical field.

Essentially due to the underlying electro-optical effect, the propagation behavior of a light wave along the Fraunhofer IPMS liquid crystal waveguide is dependent on its polarization state. A solution for polarization independent electro-optically induced waveguides in liquid crystals was nevertheless developed at the IPMS. In this case the optical losses in the TE and TM modes propagating along the induced waveguide can be controlled by the applied electric field distribution in the electrode backplane.

Estimates of TE and TM modes transmission as a function of the applied voltage are presented in fig. 3. The data reveal that, with the current design, for single mode operation at the telecommunication C-band centered around 1550 nm, insertion loss of less than 3 dB can be achieved for extremely low polarization dependent loss.

These waveguides are fabricated at the Fraunhofer IPMS by means of precision silicon wafer level technology. This fulfills the prerequisites for high quality, high volume and cost efficient manufacturing. A demonstration of a polarization independent waveguide is available.

1 1x2 liquid crystal switch/ variable power splitter

2 Polarization independent liquid crystal waveguide

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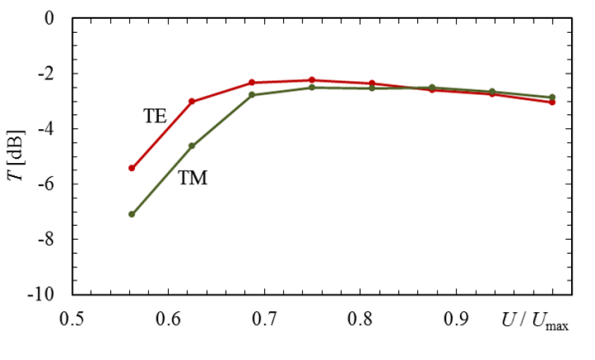

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Technical specifications

Parameter	Unit	Value
Insertion loss* (at 1550 nm)	dB	< 3
PDL	dB	< 0.1
Attenuation range	dB	0 - 40
Wavelength range	nm	400 - 1600
Optimized for wavelength	nm	1550
Switching time	µs	< 1
Voltage, U_{max} (design dependent)	V	40 - 80

** estimated for both TE and TM polarization*

Advantages

Fraunhofer IPMS has demonstrated, making use of particular arrangements of polarization dependent electro-optically induced waveguides, sub-microsecond switching, and continuously voltage adjustable, full variable range power splitting at low optical loss. With the Fraunhofer IPMS new waveguide design, also polarization independent optical switching and polarization independent variable power splitting with the mentioned characteristics are possible.

In particular, optical switching devices based on the Fraunhofer IPMS waveguide concept can provide the following key features: fast switching speeds, polarization insensitive operation, good reliability and stability of the switching process, scalability towards high channel count and integrability with other devices, large number of switching cycles as well as low insertion loss and low crosstalk.

Usage

An optical switch device based on polarization independent electro-optically induced waveguides can be used for directing signals from multiplexed fiber optic sensors for their cycling analysis in interrogation instruments. For fiber optic sensor network monitoring, the device can ensure switching between channels at frequencies in the MHz range. Moreover due to the absence of mechanical parts, the device can operate nearly wear-free and can therefore be the technology of choice for long-term monitoring applications.

In optical telecommunications networks, devices based on polarization independent electro-optically induced waveguides can ensure dynamic switching between different channels, control of power allocated to network nodes and increased efficiency by utilizing optical resources at a lower cost.

3 *Estimated transmission in polarization insensitive liquid crystal waveguide*

Key features

- Polarization controlled operation:
  - Polarization sensitive OR insensitive
- Single mode design
- Fiber optic coupling to LC waveguide
- Full variable range optical power splitting
- Continuously voltage adjustable output characteristics
- Reliability due to the absence of mechanical parts
- Wafer scale fabrication with precision silicon micro-technology
- Scalability and reconfigurability of induced waveguide functions
- Integrability with other devices on a same chip

Applications

- Fast switching for fiber-optic sensor network monitoring (MHz)
- Optical telecommunication networks
- Signal monitoring
- Fiber-to-fiber interconnection
- Signal attenuation and power splitting
- Laser system technology

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

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