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Integrated optical time division reflectometer

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An optical time domain reflectometer (OTDR) is a device commonly used for testing and monitoring of fiber-optic networks of every kind [1,2]. Despite significant progress in the field, it should be noted that contemporary devices are typically bulky, comprising discrete optoelectronic components and designed for monitoring of a single optical fiber link only. In this work we propose two application specific photonic integrated circuits (ASPICs) designed and developed for a novel OTDR system, which combines the advantages of compactness and multi-channel operation.

The first ASPIC is a single channel reflectometer and its scheme is presented in Fig. 1. Probing light pulses are generated by means of direct modulation of the DFB laser, while detection of the backscattered and reflected light is performed by a photodiode. The chip input/output is connected to the source and the detector through a 2×2 MMI coupler. Fig. 1 presents also a microscope photograph of the device (dimensions 6 mm × 4 mm) fabricated in a generic process provided by Heinrich Hertz Institute [3].

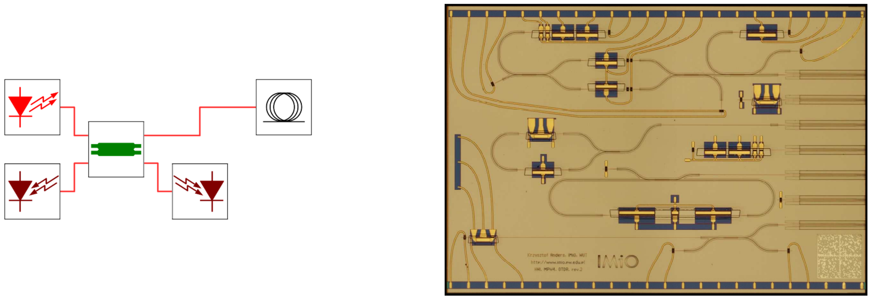

Fig. 1. Integrated OTDR – circuit scheme (left) and microscope photograph of the fabricated ASPIC (right).

ASPIC characterization was performed using the measurement setup presented in Fig. 2. The DFB laser was driven through a bias-tee from a pulse generator and a source-measure unit. The photodiode was reversely biased and the voltage signal from the resistor was visualized on the oscilloscope. Fig. 3 presents recorded time traces obtained after launching optical pulses (1 μs pulse duration, 4 kHz repetition rate) to an optical fiber link of a total length of 5 km, 10 km and 20 km. The backscattered signal was too weak to be detected directly on the resistor. However, the reflections from the end of the fiber link were detected and the value of the time delay was coherent with the length of the link.

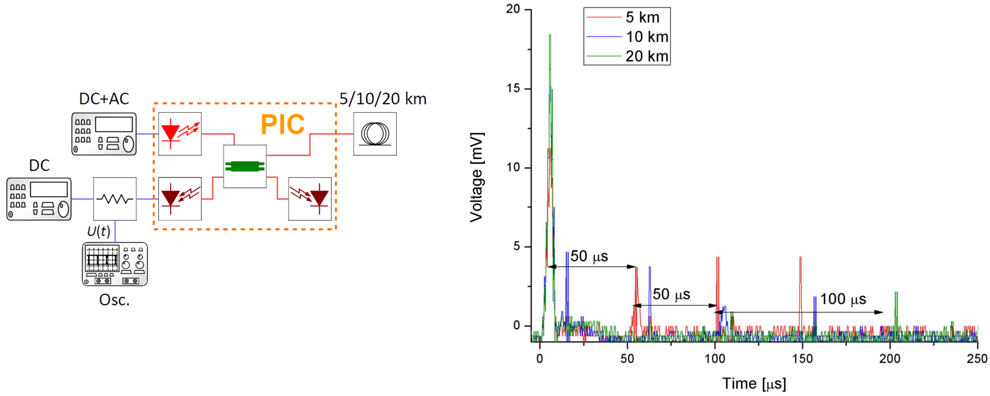

Fig. 2. Measurement setup used for characterization of a single channel integrated OTDR (left) and recorded time traces (right)

The second ASPIC, realized in the generic process of SMART Photonics [3], is a multi-channel reflectometer. Fig. 3. presents a scheme of a two-channel photonic circuit, which comprises Fabry-Perot lasers as light sources, combined with amplifiers to boost the output power. The lasers can be either directly or externally modulated using a Mach-Zehnder modulator. The optical signal is coupled to two optical IOs through a cascade of MMI couplers. The fabricated chip (dimensions 4.6 mm × 4 mm) is presented in Fig. 3.

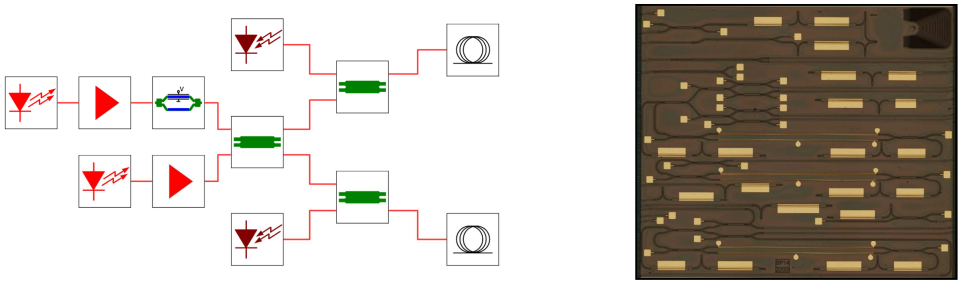

Fig. 3. Multi-channel integrated OTDR – circuit scheme (left) and microscope photograph of the fabricated ASPIC (right).

As a result of this work two integrated OTDR photonic integrated circuits were designed and fabricated using generic foundry processes. Initial characterization results confirm the potential and applicability of the photonic integration technology for this application.

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References

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