Nano Scale Disruptive Silicon-Plasmonic Platform for Chip-to-Chip Interconnection

Chip to chip interconnect characterization

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Executive Summary

Milestone 41 concerns the chip-to-chip interconnect characterization. In this context, deliverable 6.3 (and partly also 6.4) were submitted in accordance with the NAVOLCHI "Description of Work". As briefly discussed in milestone report 50, the optical link between transmitter and receiver is realized with multicore fibers (MCFs) and explained in more detail in the following

Change Records

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2	2015-09-21		Claudia Hoessbacher

Chip-to-chip interconnect characterization

Multicore Fiber Characterization

The optical interconnect between the chip must provide minimum light loss and the possibility to place an additional optical amplifier between the two chips. This link is a particular challenge, since the distance between NAVOLCHI's optical channels is only 50 µm. State-of-the art fiber-to-chip interfaces frequently use fiber ribbons and plastic interconnect. However, the typical spacing of ribbons (125 µm) does not allow particular dense integration, and, furthermore, plastic interconnects do not allow for additional optical amplification. Multicore fibers that are matched to out-of-plane surface couplers provide both, a dense optical interface and the possibility to easily use optical amplifiers between the chips. This is why, the consortium decided to use multicore fibers (Chiral Photonics, PROFA) as shown in Fig. 1. The multicore fiber consists of 19 channels with a pitch of 50 µm where we use four for our system demonstrator. Transmission measurements showed a power penalty compared to standard single mode fibers of less than 1 dB. To investigate the optical crosstalk of the dense optical interface 4 different wavelengths (1543.5 nm…1545.0 nm) were fed through 4 different channels (ch1…ch4) of the MCF, while coupling to silicon waveguides (WGs) without MZMs. The optical output spectrum of each channel was recorded using an OSA. Crosstalks were found to be lower than -31 dB in any instance. As an example we discuss the crosstalk into channel 2. The spectrum of channel 2 is shown in red. A main peak at 1544.0 nm is found which corresponds to the wavelength fed to channel 2. Besides, smaller peaks at the wavelengths of the neighboring channels appear in the spectrum.

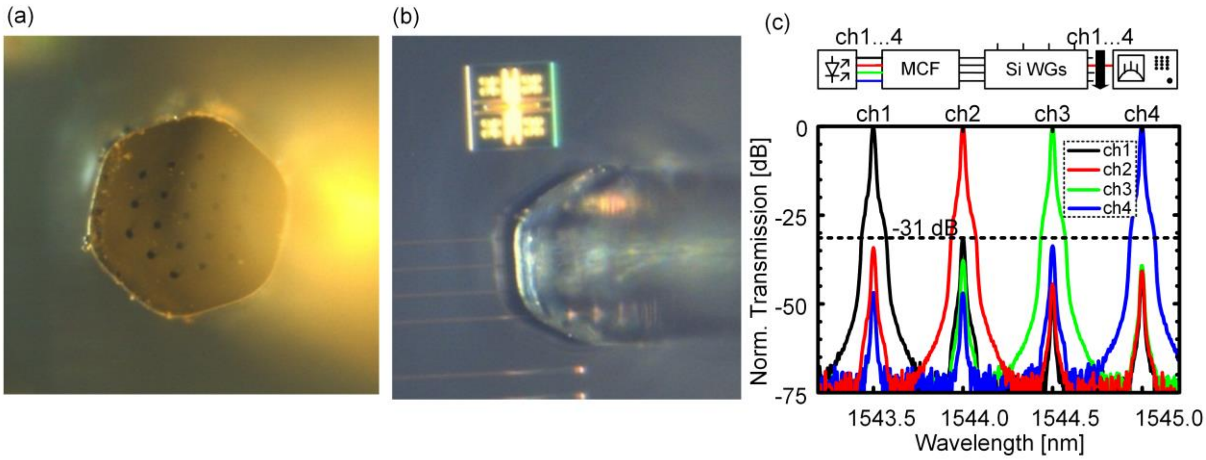

Fig. 1 Multicore fiber: (a) facet with 19 channels; (b) top view when coupling to four channels on chip. (c) Optical interchannel crosstalk below -31 dB for four channels. The spectra were obtained by coupling four different wavelengths to the multicore fiber.

Interconnect solution

The interconnect solution envisioned here is made possible by dense plasmonic modulator arrays. Such plasmonic modulators can be integrated with plasmonic detectors and with electronics, making them attractive transceivers for data center applications. Fig. 2 illustrates two operation scenarios, with space-division multiplexing (SDM), Fig. 2(a), or wavelength-division multiplexing (WDM), Fig. 2 (b). In both scenarios, light of centralized lasers is distributed via a switch and MCFs to the integrated transceivers. The same MCFs also provide connection for optical input and output signals of the transceivers. They couple light to matched on-chip grating coupler (GC) arrays. In the SDM application scenario, Fig. 2 (a), the transmitter (Tx) is fed by a single laser source. The laser signal is then split on chip, fed to four modulators and is encoded with information. Each signal is sent back through a different core of the MCF. The modulated signals are fed to a central switch from where they are distributed to remote locations and receivers (Rx). In the Rx, the signals are received in a direct or coherent detection scheme using the LO. In the WDM scheme, Fig. 2 (b), the interconnect is fed by external lasers emitting a set of wavelengths, four in this example ($\lambda_1 \ldots \lambda_4$). The transmitter consists of a modulator array followed by integrated or external multiplexers (MUX). At the receiver, a demultiplexer separates and individually detects the wavelength channels.

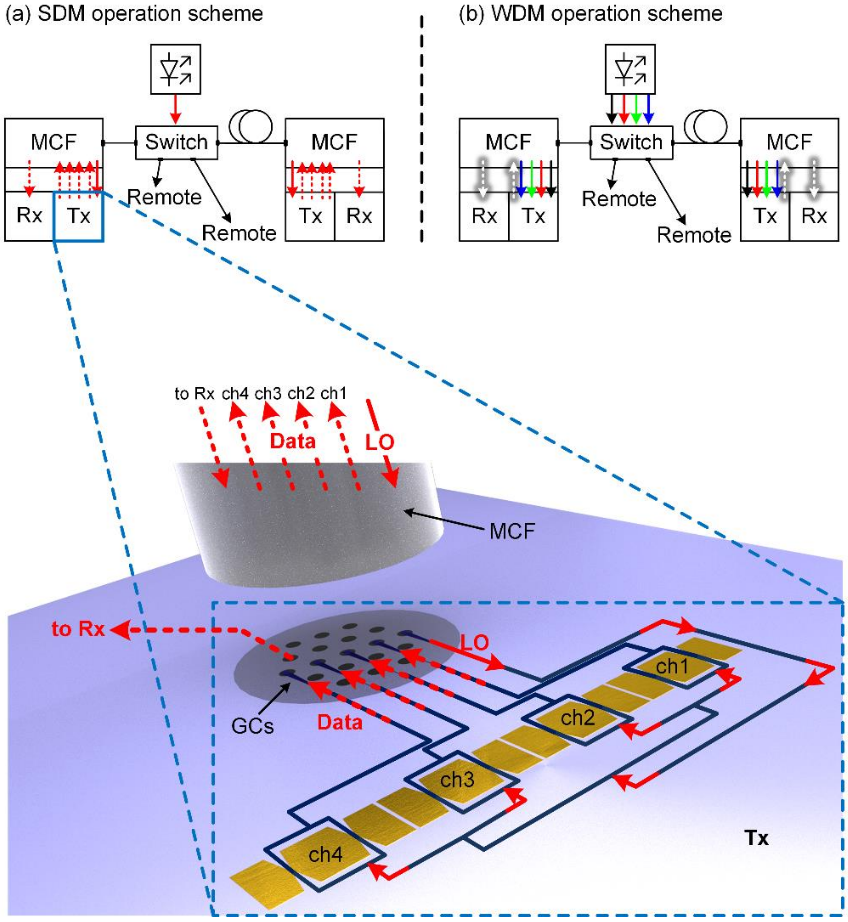

Fig. 2(a) Space division multiplexing scheme with blow-up of the compact plasmonic transmitter (Tx) for high-speed optical interconnects in data center applications. The interconnect is fed by a central laser source, while a switching network distributes the signals. The central laser signal (LO, solid line) is interconnected by a multicore fiber (MCF) to the integrated plasmonic Tx via grating couplers (GCs). The Tx splits the laser into four channels and sends each signal to a modulator, so that several data streams are encoded. The individual signals are then sent back through different cores of the MCF (dashed lines). Finally, the modulated signals are distributed by the switch to the receivers (Rx) (b) Wavelength division multiplexing scheme where the MCF carries laser light of different wavelengths that may be multiplexed on chip or externally.