Folded Micro-optical Connectivity Solution

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Current optical connectivity solutions use optical fibers as transmission media for long and medium distance communication. In short range data communication, the electrical interconnects are being replaced with optical ones for optical transceivers for data-and telecom. However, up to now, most of the available solutions are based on straight optical connectivity. In this project, CSEM demonstrated the feasibility of micro-optical elements capable to deflect the light by 90 degrees. The origination and replication of such micro-structures rely on wafer-scale fabrication processes, which enable a cost effective technology platform for mass volume production.

Current optical connectivity devices are mainly based on straight solutions for light coupling. However, with the transition of optics closer to the device (e.g., for connected devices) and even to monolitic chip integration, space is becoming more and more limited. In particular, datacom applications require interconnections to active optical devices (e.g., lasers, LEDs and detectors), to waveguides in electro optical boards, and to waveguides in photonic integrated circuits (PIC), where it is essential to have a compact folded optical connection (preferably at 90 degrees).

In this project, two reflective solutions were evaluated, i.e: a 45-degree mirror and a quarter ball lens (Q-Lens), both exploiting total internal reflection (TIR). For the low-cost manufacturing of these micro-optical elements, UV polymer replication was chosen. Additional alignment walls were implemented in the layout design in order to enable passive optical fiber alignment (Figure 1).

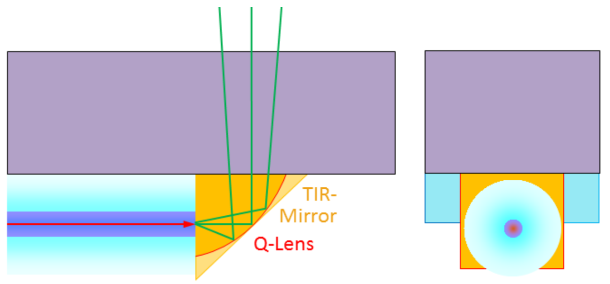

Figure 1: Schematic of Q-lens and micro-prism directly replicated on a wafer (a) Side view of the optical configuration. (b) Coaxial view of the glass fiber hold by the alignment walls.

The geometry of the micro-optical structures was designed targeting the application both to multimode fibers (MMFs, operating at 850 nm with a core size of 50 µm and a numerical aperture NA = 0.20) and to single mode fibers (SMFs, operating at 1300nm with a core size of 9 µm and a numerical aperture NA = 0.13).

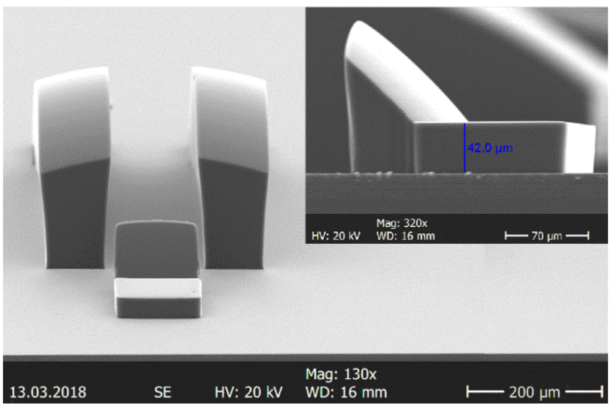

Figure 2: Scanning Electron Microscope (SEM) image of a Q-lens on wafer with alignment walls.

The fabrication of the masters for the 45-degree mirrors and the Q-Lenses was realized with direct laser writing plus chemical post polishing and photolithography plus resist reflow processing, respectively. Note that the definitive Q-lens shape together with the alignment walls is obtained by UV-molding with the photomask defining the final shape on the wafer (Figure 2).

In order to compare the performance of the Q-Lenses with respect to the 45-degree mirrors, optical losses were measured with a Kingfisher multi-fiber (E9 & G50) and multi wavelength (850, 1310 & 1550 nm) light source and an InGaAs (918D-IGOD3R) detector from Newport (Figure 3). To check the quality of the end facets, the horizontal (x-axis) beam profile was measured using a 200 micron detector fiber at different positions along the beam propagation axis

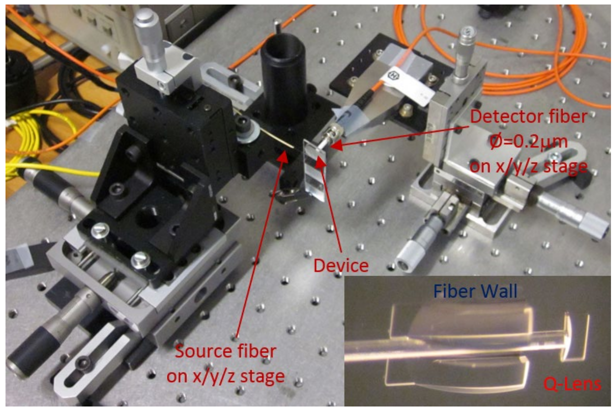

Figure 3: Optical characterization setup to measure beam profile at different propagation distances.

The measurement (Figure 4) show that the Q-lenses provide the best optical performances with negligible losses with respect to commercial single micro-prisms (i.e. ≈ +0.5 dB).

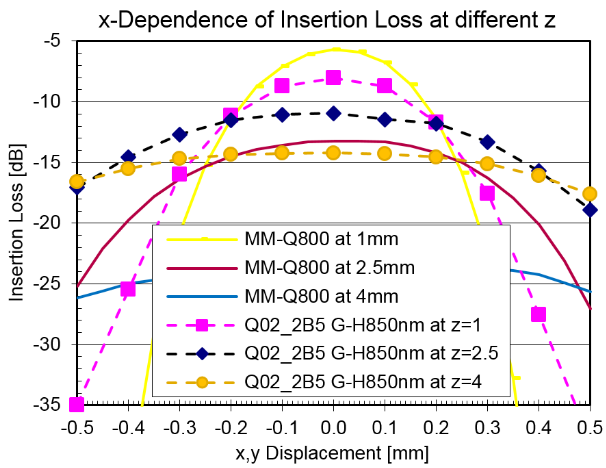

Figure 4: Optical measurements of beam profile at different propagation distances.

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