Executive summary

BOOM has been a photonic integration concept aiming to develop compact, cost-effective and power efficient silicon photonic components for high capacity routing applications. The project has focused on a hybrid integration technology allowing Si manufacturing with III-V material processing for the implementation of a wide range of optical functionalities, including high speed optical transmission, modulation and wavelength conversion, on the silicon-on-insulator substrate.

BOOM has invested on the micro-solder fabrication technique for the hybridization of active components on silicon boards. The Au-Sn bumping process has reached adequate level of optimization during the BOOMing years. A key-milestone success has been the flip-chip bonding of SOAs and EML transmitters on the SOI boards with placement accuracy down to submicron level enabling the fabrication of silicon-on-insulator hybrid components with good electrical/optical properties. This has been a major achievement since it proved that the current flip-chip assembly technology could certainly provide mounting capabilities well below the multi-mode fiber limit. Compared to other techniques, BOOM micro-soldering technology has been more flexible and compatible with advanced III-V processing steps.

BOOM has advanced the state-of-the-art in photonic wavelength conversion devices developing scalable all-optical wavelength converters (AOWCs) with record integrated line-rate performance. In contrary with silica-on-silicon demonstrations, BOOM converters have increased aggregate switching capacity by a factor of 4, assisting for first time data rates up to 160Gb/s. In terms of footprint, silicon wavelength converters have been more compact devices (10 times squeeze) due to their high refractive index material. With respect to energy consumption, BOOM devices consumed less power (by a factor of 7) compared to Mach-zehnder interferometric structures due to the utilization of only one active element for the wavelength conversion process.

The InP-photodetectors developed in BOOM have been in direct competition with Ge-detectors for integration with silicon waveguides. Their hybridization has been performed with the heterogeneous wafer-scale integration technique. A persistent difficulty with this approach has been the high series resistance and the non-uniformity BCB layer thickness limiting the high-speed optical transit time of the detectors. From a fabrication point of view, a key success has been an adaptation in the flow process mechanism in order to minimize contamination of the surface prior to metal deposition ensuring good metal/semiconductor contact. From the design point of view, a significant improvement has been performed in the III-V epitaxial growth so as the photodetector to be more transit time limited than RC limited. The new technological methodology has been proved reliable and fully extendable to other materials and other wavelength ranges.

As general conclusion, BOOM has offered mature technology setting the basis for large scale implementation of cost-effective and power-efficient silicon components. BOOM has faced difficulties but eventually succeeded in demonstrating reliable and state-of-the-art components. In our opinion, BOOM has been a highly successful project that turned silicon photonics into a stable and powerful integration platform.