A Versatile Silicon Photonics Platform for Integrated Optics Applications

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Introduced in the middle of the 80s, Silicon Photonics recently emerged at the industrial level to answer to the need of low cost and high-speed 100Gbits/s transceiver [1]. Currently prototypes of 200 Gbits/s and 400 Gbits/s transceivers are available, and research towards efficient system for high bandwidth switches and ASICS communication has started. Although only Si-Photonics has the potential to fulfill the requirements of system requiring bandwidth of several Tb/s, those applications remains far from the consumer market. Nevertheless, Si-Photonics has also a great potential for automotive applications, such as LiDAR or Gyroscope, health-care applications (bio-sensing), and quantum computing. Therefore, versatility of the device offering in the platform development is key to ensure the compatibility with a wide range of applications. We developed the DAPHNE Si-Photonics platform with such an objective. In order to support versatile applications, basic requirements are the availability of several process options allowing multiple configuration of optical passive devices, low propagation loss, availability of efficient edge and surface coupling and efficient modulators. For this purpose, our process relies on immersion lithography patterning of the 300nm thick SOI layer, using multiple slab thicknesses (160nm,50nm and full etch), and on the introduction of a 600nm thick PECVD SiN layer above the Si layer [2] (fig1). As shown on fig. 2, this combination allows co-integrating different types of devices such as low loss rib waveguide (<1dB/cm), SiN strip waveguide (0.6dB/cm) and rib waveguides (<0.1dB/cm). As a demonstration, we fabricated, using the SiN layer, polarization management devices, mux and de-mux for CWDM standard, interposer to chip optical wideband adiabatic couplers, and SiN ring resonator. As an illustration, this device is used as sensor and showed 300nm/RIU efficiency in aqueous solution [3]. If current designs are optimized for the O and C bands, the SiN layer can be used in a much wider range of wavelengths, up to the visible range, increasing the potential application scope of the platform. Efficient PN junction based modulators and Ge photodiodes are also integrated. For example, 50nm thick slab allows obtaining efficient PN junction based modulators with $V\pi L\pi$=1.9V.cm and 0.55dB/cm loss, optimizing the OMA in transceiver application. We also demonstrated the integration of Si based SIS phase shifter using a planarized nPoly-Si/SiO2/pSi waveguide [4], showing $V\pi L\pi$= 0.6 V.cm for lower speed application where compact designs are mandatory. Finally, this platform is compatible with backside processing, allowing for instance heterogeneous integration of InP/InGaAsP materials to fabricate hybrid laser [5] or modulators.

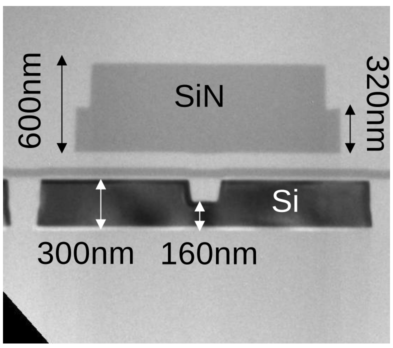

Fig.1 : multipatterning in SOI and SiN layers

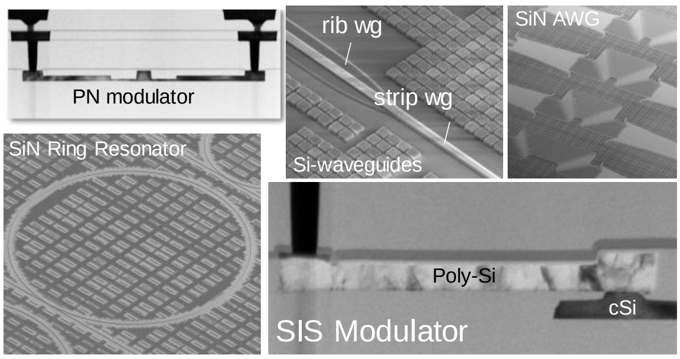

Fig.2 : example of devices in the DAPHNE platform

References [1] F.Boeuf et al., J. Lightwave Technol. 34, 286-295 (2016), [2] F. Boeuf et al., SSDM 2018, [3] M. Calvo et al., submitted to JJAP (2018) [4] C. Baudot et al., p34.3.,IEDM 2017 [5] J. Durel et al., p22.2, IEDM 2016 . **Acknowlegement** : this work has been partially supported by the Institut de Recherche Technologique (IRT), and by European Commission's H2020-ICT-27-2015 COSMICC, grant agreement N°688516