The Role of Ion Beam Technology in the Development of 2nd Generation Silicon Photonics

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The dawn of 2nd generation silicon photonics arrived with the demonstration by Intel of an optical modulator with a bandwidth >1GHz formed using a process flow compatible with that used to fabricate CMOS devices. Since that time the speed of silicon-based optical devices has increased to the extent where both modulation and detection is possible at processing rates >30Gbsec^{-1}. Further, through an elaborate hybridization approach, several groups have now demonstrated the integration of optical emission in silicon photonic chips [1]. The development of this "needs driven" functionality is a testament to manufacturing protocols which have been in place over five decades of silicon device fabrication. There remains though a desire to develop equivalent functionality using monolithic fabrication technology with no recourse to III-V hybridization (in the case of emission) or heterogeneous germanium growth (in the case of detectors). To this end, work proceeds in a number of silicon photonics research groups using silicon structures which appear to behave unlike silicon! Although many approaches have been proposed, the overarching theme is towards fabrication of such structures which are relatively small such as sub-micron waveguides and nano-dimensional crystals. This talk will describe work which uses both "top-down" and "bottom-up" engineering to fabricate monolithic, sub-bandgap detection, efficient modulation and monolithic light emission [2, 3]. The importance of the use of ion beam technology in achieving such functionality in a controlled and repeatable manner will be emphasized.

[1] A S Liu et al., *High-speed optical modulation based on carrier depletion in a silicon waveguide*, Optics Express, **15** (2007) 660.
[2] J D B Bradley, P E Jessop, and A P Knights, *Silicon-waveguide-integrated optical power monitor with enhanced sensitivity at 1550nm*, Appl. Phys. Lett., **86** (2005) 241103
[3] J N Milgram, A P Knights, K P Homewood, and R M Gwilliam, *Considerations for Interpretation of Luminescence from Silicon-on-Insulator Light Emitting Structures*, Semiconductor Science and Technology, **22** (2007) 1104.

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