Integrated III-V semiconductor/silicon photonic integrated circuits for bio-medical applications

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Spectroscopy of biological matter is a promising technique for diagnostic and monitoring purposes and for fundamental research. Since most molecules have fingerprint absorption lines in the near and mid infrared, this technique allows for a selective analysis in a non-contact mode. The current technologies in which these spectroscopic systems are implemented however don't allow realizing low cost solutions (necessary for a disposable *in vitro* measurement system) nor realizing very compact solutions (e.g. necessary for body implants).

In this paper we propose the use of an integrated III-V semiconductor / silicon photonic waveguide circuit to reduce the cost and size of such optical systems. Silicon photonics allows realizing ultra-compact optical circuits at low cost, given the fact that CMOS fabrication tools can be used for their realization on 200 mm silicon-on-insulator (SOI) wafers. In this paper we demonstrate novel components for such a spectroscopic system, realized on a single SOI chip made in a CMOS fab. Silicon photonic devices allow realizing ultra-compact, low-cost passive optical functions, such as an integrated spectrometer operating in the near and short wave infrared. For light emission and detection however, III-V semiconductors need to be integrated on top of the silicon waveguide circuit, preferably in a wafer-scale fashion. We have developed this technology, both for the near infrared (InP) and the short wave infrared (GaSb). This process allows to intimately integrate active and passive optical functions on a single chip in a low-cost fashion, unlike the hybrid flip-chip techniques or bulky and costly assembly techniques that are used today.

An optically pumped hybrid III-V/silicon microlaser source operating in the near infrared and a short-wave infrared III-V photodetector integrated on a silicon waveguide circuit will be presented. These two device examples show that III-V on silicon photonic integration could become a game-changer to realize bio-medical spectroscopic systems.