INTEGRATED AMPLITUDE AND PHASE MODULATOR FOR FREE-SPACE OPTICAL COMMUNICATIONS ESTABLISHED IN THE LWIR ATMOSPHERIC WINDOW

Thomas Poletti[1,2], Salvatore Pes[1], Nour Nawfal[1], Claire Theveneau[1], Alexandre Delga[1], Virginie Trinité[1], Axel Evirgen[1], Djamal Gacemi[2], Michel Garcia[1], Olivier Parillaud[1], Jean-Luc Reverchon[1], Carlo Sirtori[2]

[1] III-V Lab, a joint lab between Thales, Nokia and CEA, 91300 Palaiseau, France, [2] Laboratoire de Physique de l'ENS, Ecole Normale Supérieure, Université PSL, Sorbonne Université, Université Paris Cité, CNRS, 75005 Paris, France

Free space optical communications (FSOC) established in the Long Wavelength Infrared (LWIR) range (8-12 μm) are very promising because of their resilience against atmospheric adverse conditions with respect to their Near Infrared-based counterparts [1,2]. Pioneering works employing Quantum Cascade Lasers for FSOC date back to early 2000s [3,4], and very recent demonstrations using discrete unipolar quantum devices are currently redefining the state-of-the-art of high-speed free-space mid-infrared data transmissions, employing both direct and heterodyne detection [5-9]. However, the deployment of LWIR-based FSOC is still limited by the availability of basic photonic building blocks and there is hardly anything but QCLs and HgCdTe detectors that are technologically mature in the LWIR range. At III-V Lab, we are developing integrated optoelectronic components based on the quantum cascade technology, in order to realize integrated photonic platforms for mid-infrared FSOC. In this work, we focus on the development of a broadband integrated amplitude and phase modulator operating around 9μm (Fig.1a-d). In particular, we discuss the design, fabrication and preliminary characterizations of the device, which is based on the Stark shift effect in asymmetrically-coupled InGaAs quantum wells (Fig.1b). Up to ~7.4dB extinction ratio, as well as ~127° phase shift per 100μm length have been estimated at 9.1μm and room temperature for ΔV=4.25V (Fig.1c). We will discuss the main limitations of the current generation of modulators, and some perspectives to improve their performance, in view of their integration in a next generation of high-speed emitters for coherent mid-infrared FSOC.