Vanadium Oxide Based Waveguide Modulator Integrated on Silicon

Jimmy John[1, 2], Régis Orobtchouk[2], P. Rojo-Romeo[1], B. Vilquin[1,] Zhen Zhang[3], Shriram Ramanathan[3], Sébastien Cueff[1]

[1]Université de Lyon, Ecole Centrale de Lyon, Institut des Nanotechnologies de Lyon, CNRS UMR5270, 36 av. Guy de Collonges, 69134 Ecully cedex, France

[2]Université de Lyon, INSA de Lyon, Institut des Nanotechnologies de Lyon, CNRS UMR5270, 7 avenue Capelle, 69621 Villeurbanne cedex, France

[3]School of materials engineering, Purdue University, West Lafayette, Indiana, U.S.

Silicon photonics is now a mature field of research with efficient passive building blocks such as waveguides, routers and modulators. Silicon, as a material though, is not the best material for light emission and electro-optical modulation functionalities. To circumvent those limitations, researchers integrate heterogeneous materials such as for example III-V semiconductors, rare-earth-doped oxides and ferroelectric oxides on silicon.

In this communication, we present a simple and innovative straight waveguide modulator design based on the phase change properties of Vanadium dioxide (VO_2). VO_2 is a strongly correlated material with unique insulator-to-metal transition (IMT) property. This IMT is accompanied by a structural modification as well as an extremely large modulation of the refractive index in the near-infrared range. We leverage this strong optical tunability in hybrid Silicon/VO_2 waveguides for optical modulation. Specifically, by spatially separating the modulator from the bus waveguide, we both exploit the changes in refractive index and extinction coefficients to maximize modulation as well as minimize transmission loss.

We will show how our design enable compact and efficient devices that can be readily integrated on standard Silicon photonics platform. We further discuss on the latest experimental results, expected performances compared to the state-of-the-art and future devices.

We acknowledge funding from the French National Research Agency (ANR) under the project SNAPSHOT (ANR-16-CE24-0004)