GDR HOWDI 2022 MEETING:
2D SWITCHES FOR RF APPLICATION

S. Skrzypczak[1], M. Kim[2], G. Ducournau[1], D. Vignaud[1], R. Gassilloud[3], A. Cresti[4], J. David-Vifflantzeff[3], Y. Deblock[1], J. Hadid[1], V. Avramovic[1], H. Happy[1], D. Akinwande[2], and E. Pallecchi[1]

[1] IEMN, CNRS-UMR8520, University of Lille, Villeneuve d'Ascq, 59650, FRANCE
[2] Microelectronics Research Center, The University of Texas, Austin, TX, USA.
[3] CEA-Leti, MINATEC Campus, Grenoble, 38054, FRANCE.
[4] Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, Grenoble INP, IMEP-LAHC, 38000 Grenoble, France

The observation of nonvolatile resistive switching in monolayers and multilayers materials [1] is promising for electronic applications. Because of the ultimate thickness of 2D layers, analogue RF switches based on 2D materials shows a favorable scaling of the cut-off frequency versus device size, compared to other emerging technologies [2]. Our RF switches are metal-insulator-metal structures consisting of a vertical junction made of metal electrodes separated by a 2D material. We fabricated devices using CVD grown hexagonal boron nitride (hBN) and molybdenum-disulfide (MoS2). The devices are embedded in a coplanar waveguide for RF measurements. The DC measurements show that the switch is in a high-resistance state until the application of a SET voltage (~2V for the MoS_2 device and ~1.3V for hBN), which brings the device into a low-resistance state. This state persists until a negative bias is applied (RESET) to force the switch into a high-resistance state. This switch being nonvolatile, the state of the switch remains after the voltage pulse, with a retention time that exceed 12 months. From the S-parameters measured in 0.25 to 320GHz band, we found low power loss due to the switch (insertion loss) in the ON state around -1dB @ 300GHz - and large attenuation across the switch in the OFF state (isolation), around -20dB @300GHz. The cut-off frequency $1/2\pi R_{ON}C_{OFF}$ exceeds 100THz. At high-bias, the static I-V characteristics of our devices exhibit a non-linear behavior. We quantify the non-linearity with a 2 tones measurement (F_1=2.365GHz and F_2 = 2.415GHz) from which we extract the Input Third-order Intercept Point (IIP3), which exceed 46dBm for hBN devices and 37dBm for MoS_2 devices. Finally, we demonstrate the potential of our devices for telecommunications applications by conducting a data communication experiment where a 100Gbit/s data rate signal encoded with a QAM16 vectorial modulation at 300GHz carrier was transmitted across our switch.

References

[1] R. Ge et al, Adv. Mater. 2020, 2007792
[2] R. Ge et al., Nano Lett. 2018, 18, 434−441
[3] M. Kim et al., Nat. Elec.,2020, 3,479–485

corresponding author : simon.skrzypczak@iemn.fr