Development of tunable THz quantum well photodetectors

C. Abadie[1], B. Paulillo[1], S. Pirotta[1], L. Li[2], E. H. Linfield[2], R. Colombelli[1]

[1] *Centre de Nanosciences et de Nanotechnologies, CNRS, Univ. Paris-Sud, Université Paris-Saclay, C2N – Orsay, 91405 Orsay cedex, France*

[2] *University of Leeds, School of Electronic and Electrical Engineering, University of Leeds United Kingdom*

Developing devices (detectors, emitters) operating in the THz range is important because of perspective applications in metrology, healthcare, process control as many organic molecules absorb in this spectral range. As far as detection is concerned, most of the currently available detectors are thermal devices that have slow response times.

Our goal here is to develop AlGaAs/GaAs quantum well infrared photo-detectors (QWIP) with a resonant frequency around 3 THz (≈100µm) by using a 3D split ring resonator (SRR) inspired geometry (Figure 1). The micro-resonator is electrically an RLC circuit as depicted in Figure 1(b). It has been proven that, by changing the length of the antenna (inductive component of the circuit), the resonant wavelength tunes in the 100-300 µm range [1]. To implement an active device based on this architecture we need to overcome the problem that this 3D SRR is intrinsically a short-circuited system. A possible solution, implemented in [2], is the etching of the gold ground plane to enable the electrical injection through the active region.

In the new approach presented in this contribution, we assure the current flow in the active region by separating the two contacts with a 300nm-thick Si_3N_4 layer. Through finite elements numerical simulations, we are able to model and predict the electromagnetic behavior of the structure. The fabricated devices (SEM image in Figure 1 (c)) were first electrically characterized at room temperature. A single device ("pixel") has a resistance in the range of 1-10MΩ while the 5x5 array has a typical measured resistance of the order of 100kΩ. Further tests on the Si_3N_4 insulating layer are currently being made to improve both the electrical and mechanical robustness.

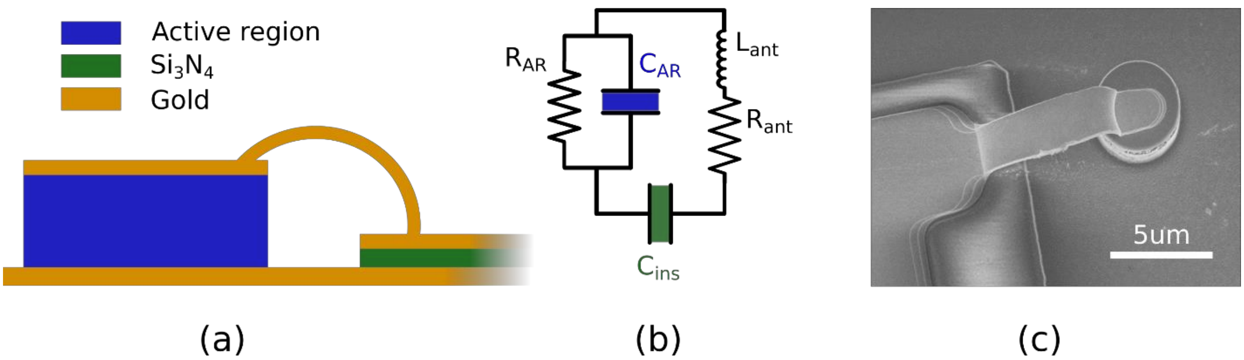

Fig.1.(a) Scheme of the new contact design. (b) Equivalent electrical circuit of the device. (c) SEM image of the fabricated sample.

[1] B. Paulillo et al. (2014), Optics Express, Vol. 22 (18), pp. 21302-21312

[2] B. Paulillo et al. (2016) "Terahertz meta-atom quantum well photodetectors" Lasers and Electro-Optics (CLEO), USA 2016.