Josephson weak links as THz radiation detectors

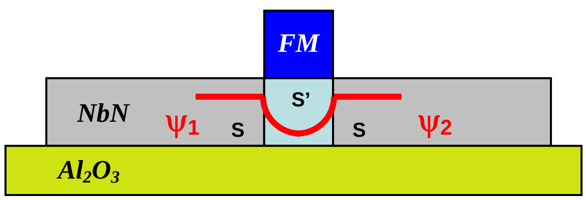
Luis B. Gómez (lgomez@physik.uzh.ch)

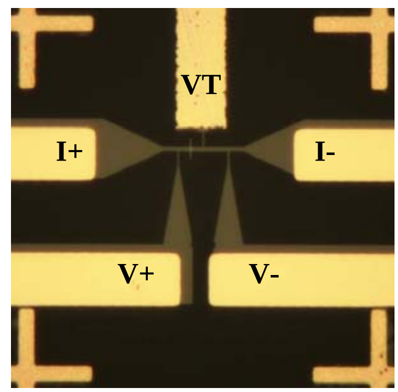
Josephson junctions are natural frequency-to-voltage transducers with great potential as THz radiation detectors through the AC Josephson effect. The Josephson current oscillation frequency (f_J) depends on fundamental constants and intrinsic characteristics of the junction, i.e.:

$$f_J = \left(\frac{2e}{h}\right) V_c = \left(0.484 \frac{THz}{mV}\right) I_c R_N$$

Where, (*2e/h*) is the Josephson frequency-to-voltage ratio, which is the inverse of the superconducting quantum flux (Φ_0), and V_c is the characteristic voltage of the junction, which is the product of its critical current (I_c) and normal state resistance (R_N). For applications, the $I_c R_N$ product is desired to be as high as possible.

Using a versatile fabrication method[1], the possibilities of creating Josephson weak links with large $I_c R_N$ products has been investigated in micrometer size NbN bridges, where a nanometer size ferromagnetic strip (FM) was deposited on top of the bridge, as shown in the figures.





The ferromagnetic strip is thought to suppress the superconductivity of the material in contact with it, through an "inverse magnetic proximity effect". Creating in this way, a superconductor-weaker superconductor-superconductor (S-S'-S) Josephson weak link. Operating the device at temperatures above the transition temperature of the weaker superconductor, but below T_c of the parent superconductor, would produce an S-N-S weak link, where the section of the bridge made normal (N) would have a large normal state resistivity, and in this way, a high R_N junction would be possible. The value of the $I_c R_N$ product would be further easily adjusted by the geometry of the junction, and it is given by:

$$I_c R_N \sim \frac{|\Delta_i|^2}{ekT_c} \frac{l}{\xi_n} e^{-l/\xi_n}$$

In this talk, we will present recent results on NbN weak links created using Ni and Gd ferromagnetic strips. In addition, attempts to detect the THz radiation produced by Quantum Cascade Lasers fabricated by Prof. Faist's group from ETH[2], will be presented.

---

[1] H. Bartolf, A. Engel, L. Gómez, A. Schilling, Raith application note, 2008. "**Multi-project wafer scale process for productive research and development"**

[2] http://www.qoe.ethz.ch/index.php?page=welcome