High Temperature Superconductors devices for telecommunication systems

R. Bernard[1], J. Trastoy[1,*], J. Villegas[1], B. Marcilhac[2], J. Kermorvant[2], Javier Briatico[1]

[1]*Unité Mixte de Physique CNRS/Thales, Université Paris Sud 11,*

1, Av. A. Fresnel, 91767Palaiseau Cedex

[2]*Thales Research and Technology,*

1, Av. A. Fresnel, 91767Palaiseau Cedex

High-Temperature superconductor (HTSC) thin films are excellent materials for the next generation telecommunication systems. Their very low surface impedance (for $YBa_2Cu_3O_7$, 30 times smaller than cooper at 77K) permits the design of very selective filters and resonators. On the other hand, Josephson junctions (based on superconductor-insulator-superconductor structures) are ideal components for analog to digital converters, which in turn, permit the conversion of the received signal in order to be numerically treated by a computer.

In this talk, I'll show a scheme of a typical telecommunication system, and the places where HTSC materials could improve microwave transceivers. We'll see how understanding the high frequency properties of thin films permits the increase of devices performance [1]. A highly compact cryogenic device designed for integration in satellites and avionics will be presented.

Finally, I'll present our recent results on Superconductor/Ferroelectric hybrid structures [2]. Using heterostructures that combine a large-polarization ferroelectric ($BiFeO_3$) and a high-temperature superconductor ($YBa_2Cu_3O_7$), we demonstrate the modulation of the superconducting condensate at the nanoscale via ferroelectric field effects. Through this mechanism, a nanoscale pattern of normal regions that mimics the ferroelectric domain structure can be created in the superconductor. This yields an energy landscape for magnetic flux quanta and, in turn, couples the local ferroelectric polarization to the local magnetic induction. We show that this form of magnetoelectric coupling, together with the possibility to reversibly design the ferroelectric domain structure, allows the electrostatic manipulation of magnetic flux quanta, and the realization of a new family of hybrid devices for nanoelectronics.

[1] Joule heating and high frequency nonlinear effects in the surface impedance of High Tc superconductors, J. Kermovant, C.J. van der Beek, J.-C. Mage, B. Marcilhac, Y. Lemaitre, J. Briatico, R. Bernard and J. Villegas, J. Appl. Phys. **106**, 023912 (2009)

[2] Nanoscale Electrostatic Manipulation of Magnetic Flux Quanta in Ferroelectric/Superconductor $BiFeO_3/YBa_2Cu_3O_7$ Heterostructures, A. Crassous, R. Bernard, S. Fusil, K. Bouzehouane, D. Le Bourdais, S. Enouz-Vedrenne, J. Briatico, M. Bibes, A. Barthélemy, J. E. Villegas, Phys. Rev. Lett. **107**, 247002 (2011)

*Fellowship from Fundación Barrié (Galicia, Spain)