Planar Tunneling Through Solid Inert Gas Barriers

Allen M. Goldman, University of Minnesota, DMR-0138209

Electron tunneling is an important probe of the electronic properties of materials. There is a problem in the fabrication of planar tunneling junctions for spectroscopic studies of very delicate materials. The processing of the tunneling barrier can lead to damage in the active tunneling volume, which will contaminate the tunneling characteristic. We have developed an approach to barrier formation that avoids damage by using a solid inert-gas as a barrier. This is a low-energy, non-chemical process which is feasible because metal layers can be deposited on top of a solid inert gas layer without obliterating it.

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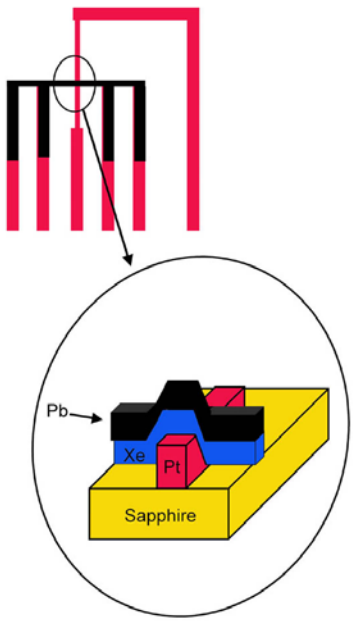
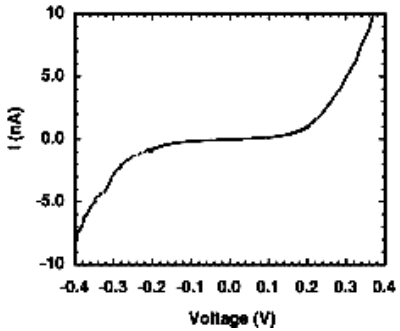


Schematic of tunneling structure. The pattern of leads permits the verification of the superconductivity of the Pb strip as well as measurement of the I-V characteristic of the junction.



Current-voltage characteristic of a high-resistance junction.

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The junctions consist of a base layer of Pt, a barrier of solid Xe, and a counter-electrode of Pb. The Pb electrode was found to be superconducting with a transition temperature of 7K. The detailed I-V characteristics of these structures are consistent with the theory of tunneling. Further evidence of tunneling, rather than direct electrical transport through an electrical short, is that junction resistances were found to increase on cooling from about 9K down to 3K. Future work will involve the use of atomically smooth substrates permitting the formation of thinner tunneling barriers. In this way the features of the density of states of Pb, characteristic of its superconductivity should become visible.

Education:

The measurements and junction fabrication were carried out by Cathryn Christiansen and Laura Adams. Dr. Christiansen is now a member of the technical staff of I.B.M. Burlington. Ms. Adams is a senior physics graduate student who should receive a Ph.D. during the 2003-2004 academic year.

Outreach:

Professor Goldman,as department head supports an outreach activity called the *Physics Force*. This group performed for aggregate audiences exceeding 40,000 during the 2002-2003 academic year. .