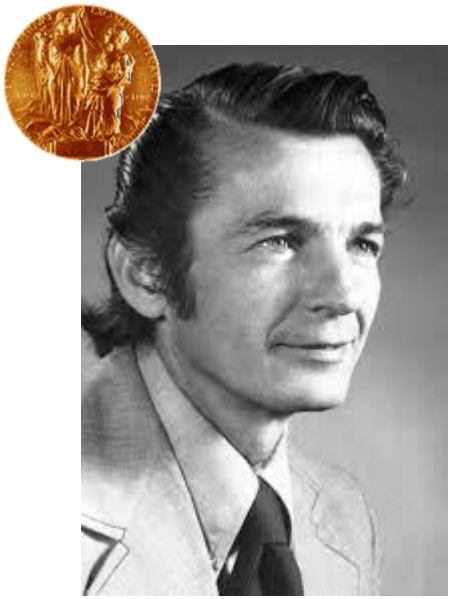
Condensed Matter	Exploring the temperature dependence of the superconducting energy gap using tunneling spectroscopy.	Lab logo: *Tunneling*

First measurements of the energy gap were done by Ivar Giaver in 1960



Ivar Giaver
b. 1929

VOLUME 5, NUMBER 4 PHYSICAL REVIEW LETTERS AUGUST 15, 1960

ENERGY GAP IN SUPERCONDUCTORS MEASURED BY ELECTRON TUNNELING

Ivar Giaever
General Electric Research Laboratory, Schenectady, New York
(Received July 5, 1960)

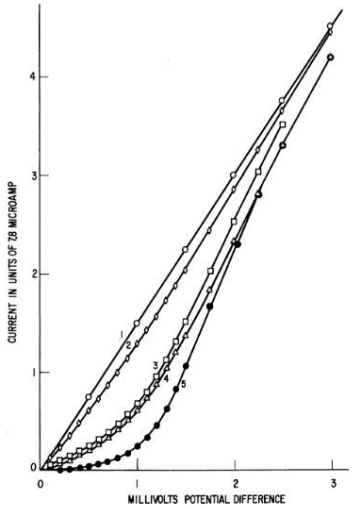


FIG. 1. Tunnel current between Al and Pb through Al_2O_3 film as a function of voltage. (1) $T = 4.2°K$ and $1.6°K$, $H = 2.7$ koe (Pb normal). (2) $T = 4.2°K$, $H = 0.8$ koe. (3) $T = 1.6°K$, $H = 0.8$ koe. (4) $T = 4.2°K$, $H = 0$ (Pb superconducting). (5) $T = 1.6°K$, $H = 0$ (Pb superconducting).

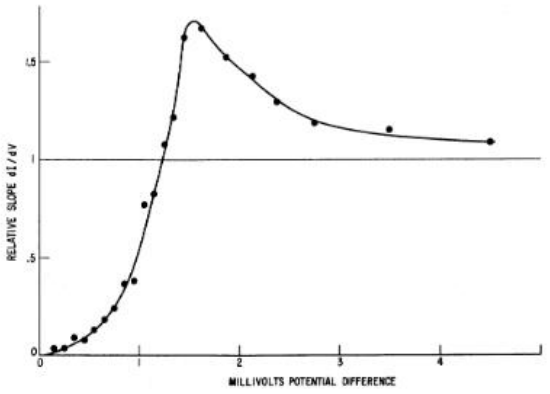


FIG. 2. From Fig. 1, slope dI/dV of curve 5 relative to slope of curve 1.

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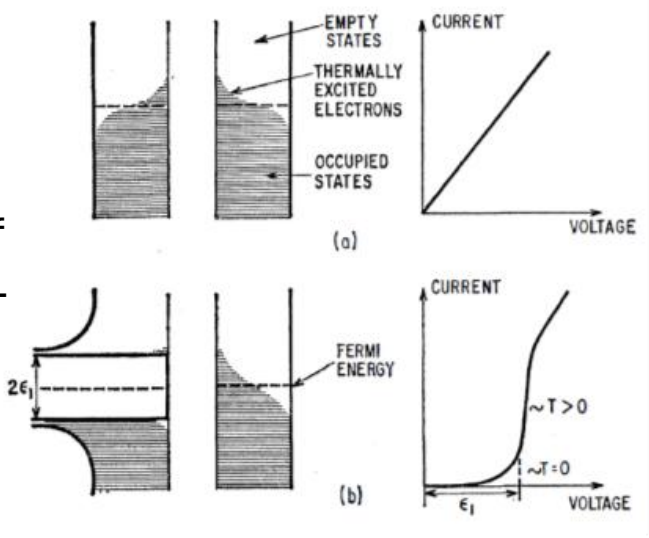
Tunneling current in M-I-M (metal-insulator-metal) Junction can be written as:

$$I = A\int_{-\infty}^{\infty} N_1(E)N_2(E+eV)[f(E)-f(E+eV)]dE \quad ,$$

A – tunneling probability, N_1 and N_2 densities of states of junction metals, V applied voltage to the junction and f – Fermi function. $f(E)=\frac{1}{e^{(E-E_F)/kT}+1}$

In case of one metal is superconductor (S) for T<Tc the density of states according BCS can be presented as:

$\frac{N_s(E)}{N_s(0)}=\frac{E}{(E^2-\Delta^2)^{1/2}}$ for E>Δ and 0 for E<Δ, Δ – energy gap



As the result the differential conductivity of S-I-N junction will be proportional to Ns

$$\frac{dI}{dV}=G_{nn}\frac{N_s(e|V|)}{N_s(0)} \quad \text{or} \quad \frac{dI}{dV}\sim\frac{E}{(E^2-\Delta^2)^{1/2}}$$

PHYSICAL REVIEW VOLUME 122, NUMBER 4 MAY 15, 1961

Study of Superconductors by Electron Tunneling

IVAR GIAEVER AND KARL MEGERLE
General Electric Research Laboratory, Schenectady, New York
(Received January 3, 1961)

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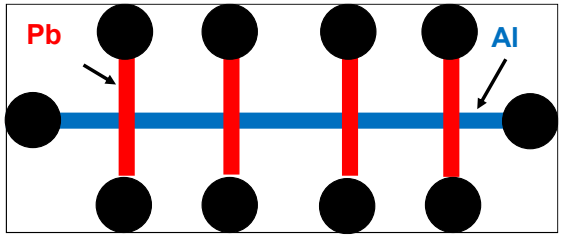
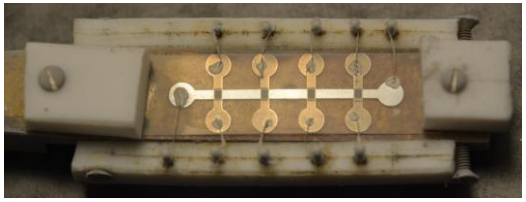
Experimental procedure



Tunneling junctions: Al stripe oxidized in air and second metal under study (Pb) deposited over the aluminum oxide



Sample mounted on the dipstick

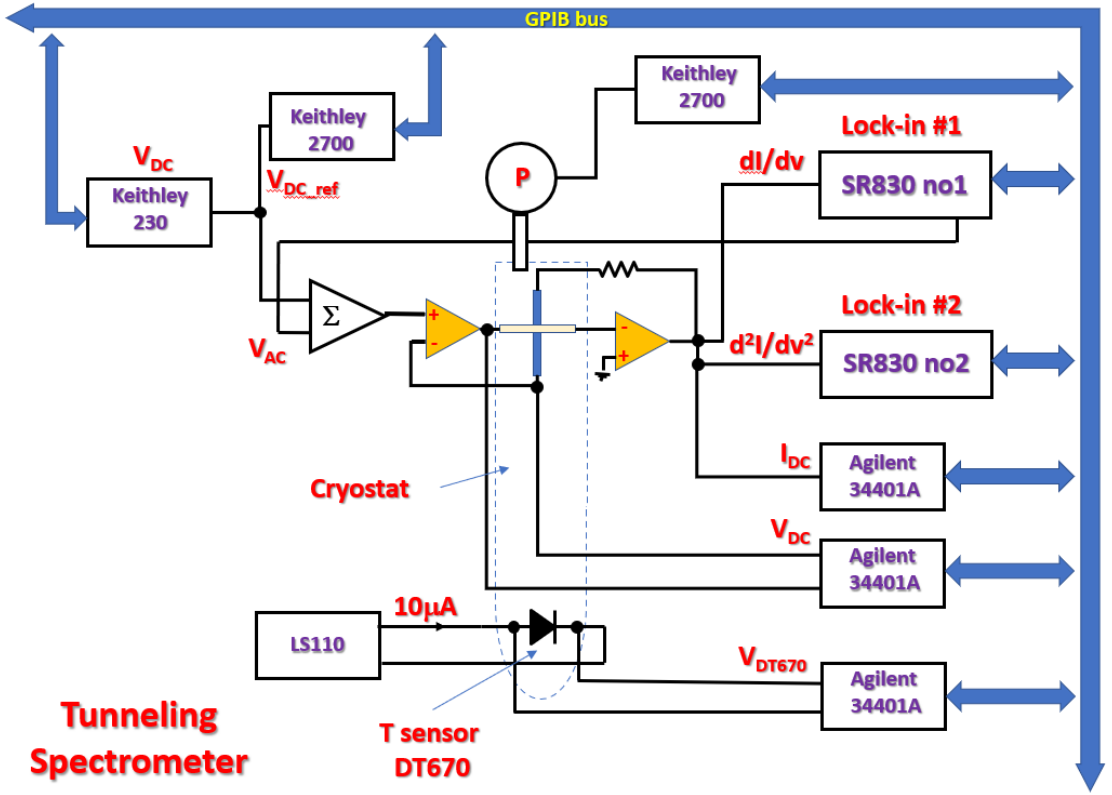


Diagram of tunneling spectrometer

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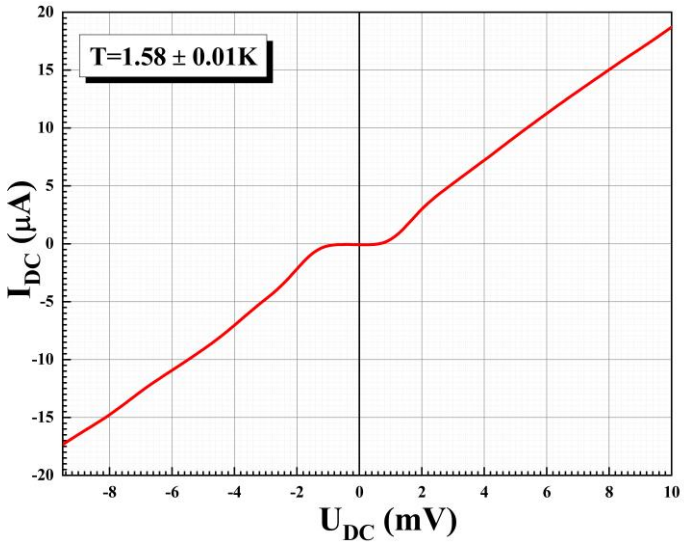
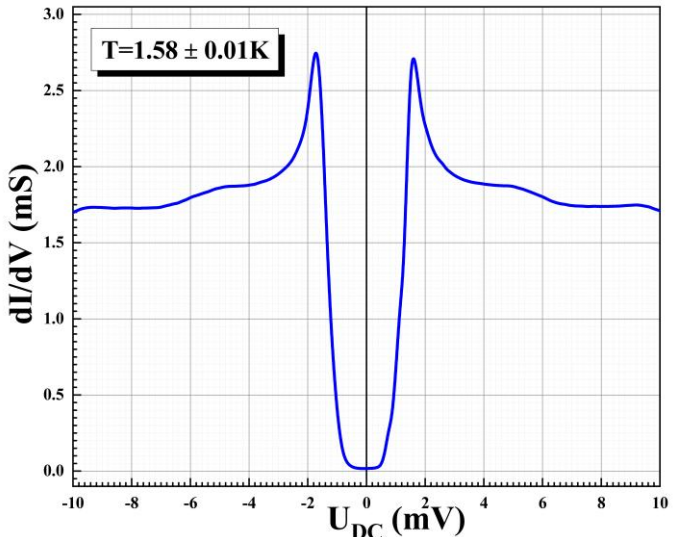
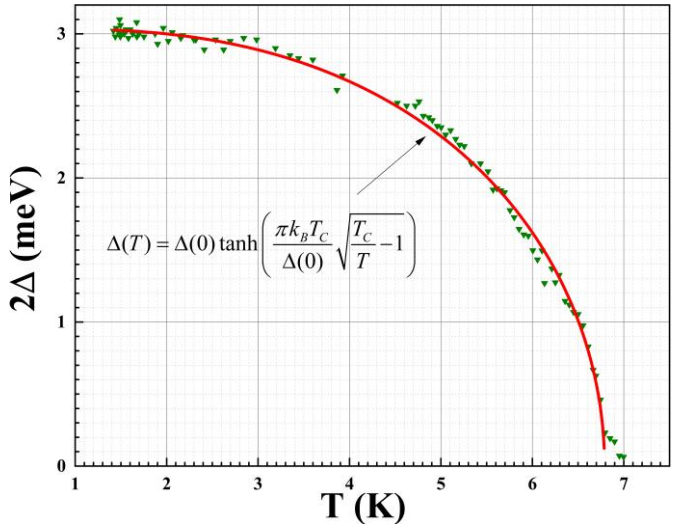
Experimental results:





Tunneling in N-I-S junction
Al-Al_2O_3-Pb

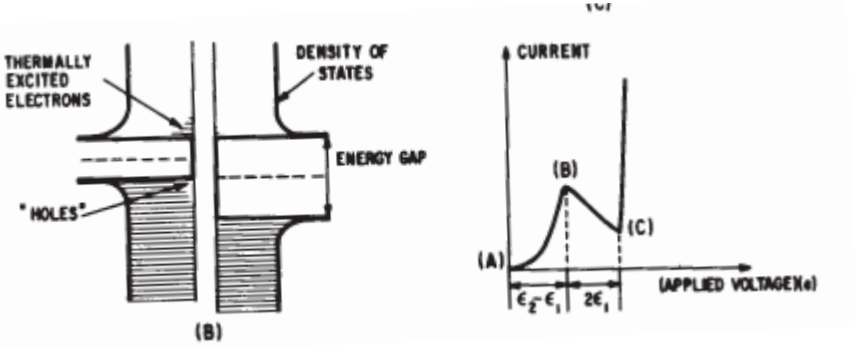


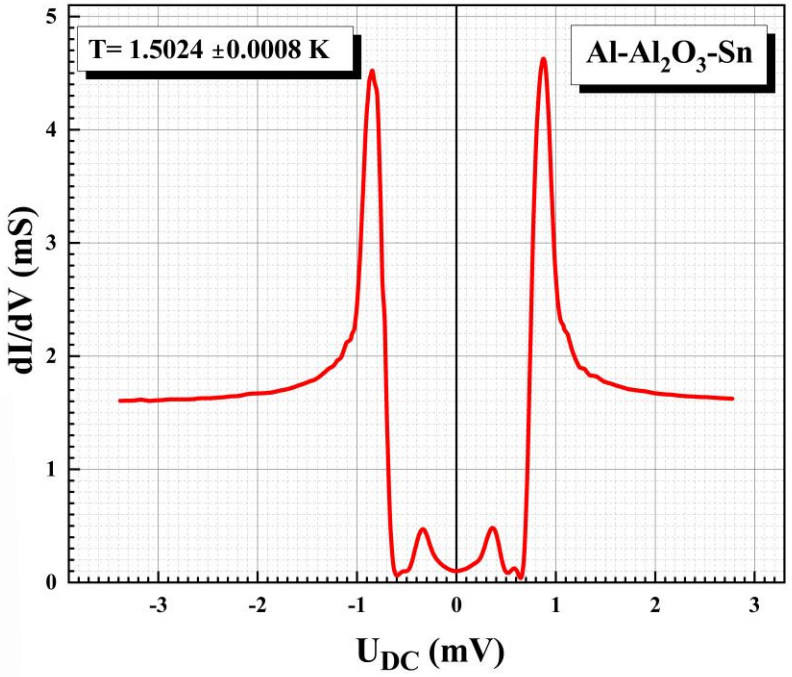
Courtesy of P403 students

Condensed Matter	Exploring the temperature dependence of the superconducting energy gap using tunneling spectroscopy.	Lab logo: Tunneling

Experimental results:

Tunneling in S-I-S system: Al-Al_2O_3-Sn; Thickness of Al film is ~ 10 nm; because of the size effect Tc for the film of this thickness rises the value close to 2K





I. Giaver, in "Tunneling Phenomena in Solids"

Courtesy of P403 students