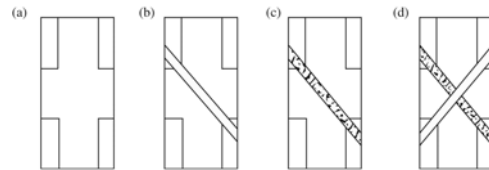


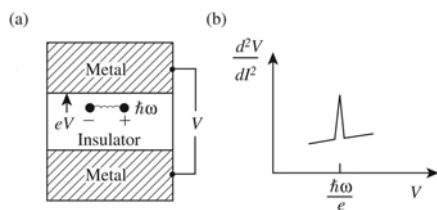
**Spring 2008 MSAE E4990y**  
**Introduction to STM and AFM**  
**Lecture 24**  
**Inelastic Electron Tunneling Spectroscopy**

**Sample Preparation for Classical IETS**



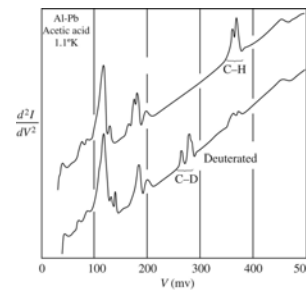
- (a) Glass slide with indium contacts.
- (b) An aluminum strip vacuum-deposited.
- (c) Oxidize Al to make a thin film of Al<sub>2</sub>O<sub>3</sub> then deposit organic molecules.
- (d) A Pb strip vacuum-deposited to form another electrode.

**Observed IETS (1)**



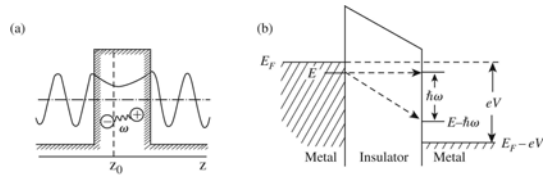
- (a) A peak in the second derivative of the I/V curve observed.
- (b) It corresponds to the vibration frequency of the molecule.

**Observed IETS (2)**



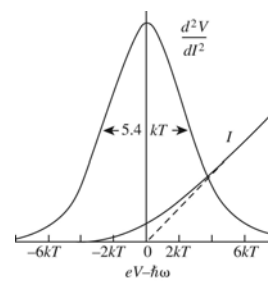
Isotope effect is the unambiguous signature of the vibration frequency of a molecule.

**The Frequency Condition**



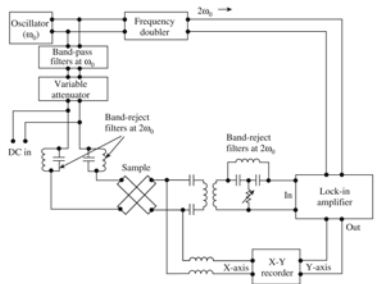
Sinusoidal excitation results in a frequency shift in tunneling spectrum.

**The Temperature Broadening**



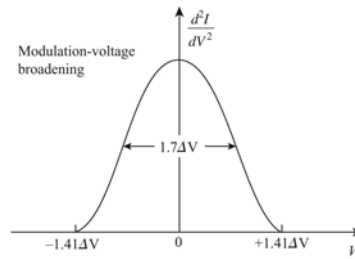
The form of tunneling spectrum and the temperature broadening can be predicted using the Fermi distribution function.

### Typical Instrumentation



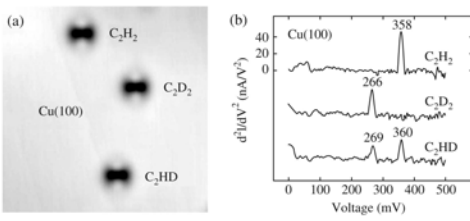
Using a lock-in amplifier to pick up the second harmonics signal..

### Instrumental Broadening



The finite amplitude of the modulation voltage causes broadening.

### Examples of the observation of STM-IETS



Isotope effect is clearly observed for different variations of acetylene.