TUNNELING DISPLACEMENT TRANSDUCERS

In 1986, Binnig and Rohrer were awarded the Nobel Prize in Physics for the scanning tunneling microscope (STM). The physical basis for the surface profiling transducer (SPT) used in the STM is the phenomenon of electron tunneling. It represents the flow of electrons between two conducting surfaces under the influence of a bias voltage. The resulting tunneling current or the tunneling effect63 is a measure of the separation between these conductors.

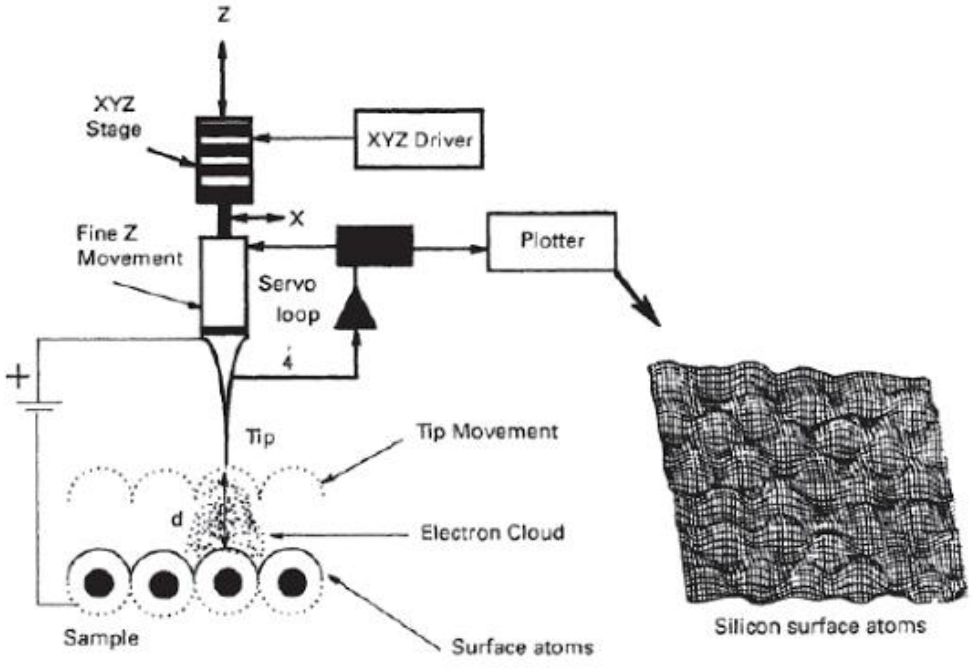

Figure 5.29 Transduction mechanism of the tunneling displacement transducer.

Figure 5.29 illustrates the transduction mechanism of the SPT. In practice, one of the conductors is replaced by an extremely fine tip and the other conductor is the surface to be profiled. When the clouds of electrons surrounding the tip and the sample surface are made to overlap and a bias potential is applied between them, a tunneling current it is established. This current can be represented by

$$I_t \propto e^{-2d/S_0} \qquad (5.24)$$

Where d is the distance between the tip and the sample surface and S0 is a constant for a given work function. It is an extremely sensitive function of the distance d. In practical terms, when the tunneling current is well established, a change in d equal to one atomic diameter will change it by a factor of 1000.

The SPT utilizes this sensitivity in a STM to profile the surfaces of materials at the atomic level. The scanning can be done in vacuum, liquids, or gases.

The angstrom movements in an STM are achieved with Inchworm* motors and a scanning tube.65,66 The image shown is of atoms on the surface of a silicon substrate.

Based on similar principles, but on a transduction mechanism that involves repulsive forces, an atomic force microscope (AFM) has been developed for surface profiling.

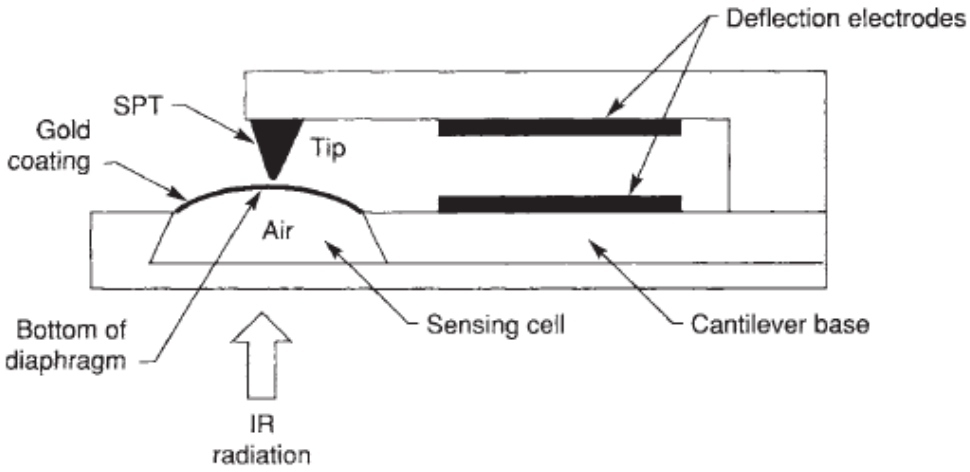

Fig 5.30 Infrared radiation transducer.

The SPT has also been used in an infrared radiation detector68 as shown in Fig. 5.30. The tip can be lowered and raised by means of an electrostatic force between two electrode surfaces of the cantilever. The infrared sensor consists of a gold-coated membrane that traps a small volume of air or helium between itself and the base of the transducer. The radiation that is absorbed by the gold coating causes the gas to expand and deflect the membrane. The deflection, which is measured by the SPT, is a measure of the infrared radiation.

Source: http://mediatoget.blogspot.in/2012/07/tunneling-displacement-transducers.html