

The scanning tunnelling microscope

The scanning tunnelling microscope (STM) enables us to see atoms. It was invented in the 1980s by physicists Gerd Binnig (from Germany) and Heinrich Rohrer ((from Switzerland) who were working at IBM's factory in Zurich, Switzerland. The first STM pictures of atoms were taken in 1985. Binnig and Rohrer were awarded the 1986 Nobel Prize in Physics.

The STM uses a probe to scan just above a surface. The probe monitors an electric current that flows between two conductors set about one nanometre apart. The probe is a sharp metallic point, only one atom wide, so is called the 'tip'. The distance between the surface and the tip must be carefully controlled, so any vibrations must be removed.

The current between the tip and the second conductor is called the tunnelling current. This varies depending on the distance between the tip and the surface being studied. The images produced show bright spots where a high current is present and darker areas where the current is lower. These appear as 'hills' and 'valleys'.

The STM can be operated in two ways, or modes:

1. The height is kept constant. The current at the tip is monitored as it passes over the surface. The tip is exactly parallel to the surface. This mode is used to study the electronic properties of the sample.
2. Current is kept constant. The tip moves up and down over the surface. This method produces images of the contours of the surface as the tip moves slightly higher as it passes over an atom and lower as it passes over a hollow.

The pictures are formed by a computer connected to the STM. The computer makes a grid of the surface of the substance. The tip moves over the surface, collecting tunnelling current data to 'fill in' the grid. Adjustments made in either the current (mode 1) or height (mode 2) are processed by the computer into an image of the surface that shows details of the atoms present. The image can be coloured to show different aspects of the surface.