Introduction

Invented by Binnig and Rohrer at IBM in 1981 (Nobel Price in Physics 1986).

Binnig also invented the Atomic Force Microscope (AFM) at Stanford University in 1986.

First instrument to give 3D images of solid surface with atomic resolution.

Formation of nanofeauters by localised heating or inducing chemical reactions.

Magnification 10

Magnification is
3

to 10
9 (
in x, y, and z directions (
with high resolution

Theory and Principle

STM employs principle of electron tunneling.

The quantum mechanical equation assign a non zero probability fora
on (
to tunnel through the barrier even if its energy is less than the patentia
of (
barrier.)

Two metals must be separated by a space of not more than 10nm.

Tunneling current decreases exponentially with separation between tip and
sample.

Experimental methods

the
sample

you want to study

a sharp metal
tip

mounted on a
piezoelectric crystal tube to be
placed in very close proximity to

the sample

a mechanism to control the location
of the tip in the x

y plane parallel to
the sample surface

a

feedback

loop to control the
height of the tip above the sample
(the z

axis) c

Basic Sel

up

How to operate?

Raster

the

tip

across

the

surface

at

a

distance

of

0.

21

–

17

nm.

While

the

current

between

the

tip

tip

and

sample

surface

is

measured.

And

using

the

current

as

a

feedback

signal.

The

tip

moves

over

the

sample

with

its

height

being

adjusted

continuously

to

keep

tunneling

current

constant

Tip

position

is

monitored

to

map

the

surface

topography

of

the

sample.

Tip

tungsten or PtIr alloy is used."

Tip movement in 3

. D is controlled by piezoelectric arrays.

The distance between tip and sample is between 0.2 and 0.6nm which produces a tunneling current of about 0.1

10nA.

Spatial resolution is 0.01nm in x and y directions. And about 0.002nm in z

direction giving a true atomic resolution image e

in 3

D.

Modes of Operation

Constant current

Constant current is maintained between tip and sample..

Vertical position of the tip is changed to maintain a constant curren
between the two.

Advantages

Provides excellent surface topographic contrast of the surface atom
contours.

Disadvantage

Slower scan rate.

Constant height mode

Distance between tip ~~and~~ sample is kept constant.

Constant tip position results in variations in tunneling current.

Advantage

faster scan rate possible

Imaging the structure of electrode surface

STM images of the Au(111) electrode surface

Concluding remarks

Disadvantage of STM:

1.

Making atomically sharp tips remains something of a dark art.

2.

External and internal vibrations from fans, pumps, machinery, building r
movements, etc. are big problems.

3.

UHV

STM is not easy to built and c
handle

4.

The STM can only scan conductive surfaces or thin nonconductive films ar
small objects deposited on conductive substrates. It does not work with
nonconductive materials, such as glass, rock, etc.

5

The spatial resolution of STM is fantastic, but the tenpantaneou
typically on the order of seconds, which prevents STM from imaging fast c
kinetics of electrochemical process."

STM is one the most powerful imaging tools with an unprecedented
precision. /