Scanning Tunneling Microscope(STM)

The scanning tunneling microscope with atomic resolution needs to be developed and we are trying to use more affordable materials to build the STM.

In terms of how the scanning tunneling microscope works, a small bias voltage is applied across the gap on a surface of a conductive material. Electrons can go across the gap through quantum tunneling, provided that the gap is less than 1 nm. The tip of the scanning tunneling microscope is placed on a piezoelectric scanner, which is able to conduct sub-angstrom motion in all directions. The voltage applied to the Z-axis is controlled by a feedback loop, which receives the tunneling current measured. An image can be created by measuring the Z-axis voltage as a function of scan position. Also, the scanning tunneling microscope is sensitive enough to create atomic resolution.

The STM tip is a component of the STM. The STM tip is placed in a pin socket for easy exchanging. The socket is glued into a hole drilled in an aluminum standoff. The standoff is glued to a small sapphire disk, which is connected to the buzzer’s brass electrode.

Speaking of requirements for the STM, good vibration isolation and damping are necessary. Higher frequencies will lead to errors. There are also other issues that need to be considered. For example, the influence of drift on the tunneling gap needs to be minimized in order to gain more accurate scanning results.

We also need software to make STM work. There is a Teensy software, which is in charge of scanning. It calls a function at a fixed time interval, which controls the scanning process. PI calculations are also used to change data on the Z-axis. If a line has been scanned twice in different directions, error signal data will be sent through USB. The PC software receives the data, processes them, and display them on the screen.

I am now trying to let two Arduinos communicate with each other to imitate the communication between STM and my computer. One of the Arduinos is the sender, which sends messages. The other is responsible for reading data and displaying them on the screen. I am also working on assigning different voltages to different pins once one Arduino receives the data. Then I can start working on generating graphs according to data gained from the STM.

Reference: https://dberard.com/home-built-stm/