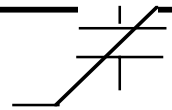
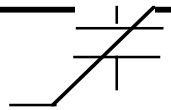


Testing Ferroelectric and Piezoelectric Samples in an AFM

Connecting to the Sample with Conducting Tip

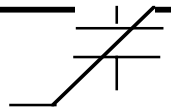
- The sample rests on the AFM chuck and electrical connections are made to the sample one of two ways:
  - Connections for the chuck and the conducting AFM probe tip come out to BNC connectors on the AFM. *NOTE: This arrangement will only work if the chuck is NOT grounded but instead is insulated from the AFM.*
    - DRIVE => Chuck BNC
    - RETURN => Conducting Probe Tip BNC
  - The AFM chuck is grounded and a conducting tip is used. In this case, a wire must be connected between the bottom electrode and the tester.
    - DRIVE => wire to bottom electrode of sample
    - RETURN => Conducting Probe Tip BNC
    - Sample MUST be isolated from the chuck by an insulator. A glass slide, a piece of electrical tape, or a piece of paper will do.



Optimal Sample Connection

- The optimal connection to the sample is as follows:
  - Wire from DRIVE to bottom electrode.
  - Wire from RETURN to bottom electrode
  - Chuck is grounded
  - Sample is insulated from the chuck.
  - Non-conducting AFM probe tip is used.

- This arrangement provides for the lowest noise injection.



AFM Frequency Response

- The vertical position control system for the AFM usually has a response speed on the order of 80KHz.
- However, the control system itself has a response on the order of 100Hz.
- To prevent distortion of the piezoelectric butterfly loop by the 100Hz response time of the AFM, the butterfly loops should run at around 1Hz (1000 millisecond period on a Radiant Precision tester).
- Electrical hysteresis speed is affected only by sample size, not AFM response time. Capacitors of 100µx100µ area can run at full speed on Radiant Precision Tester for electrical hysteresis.

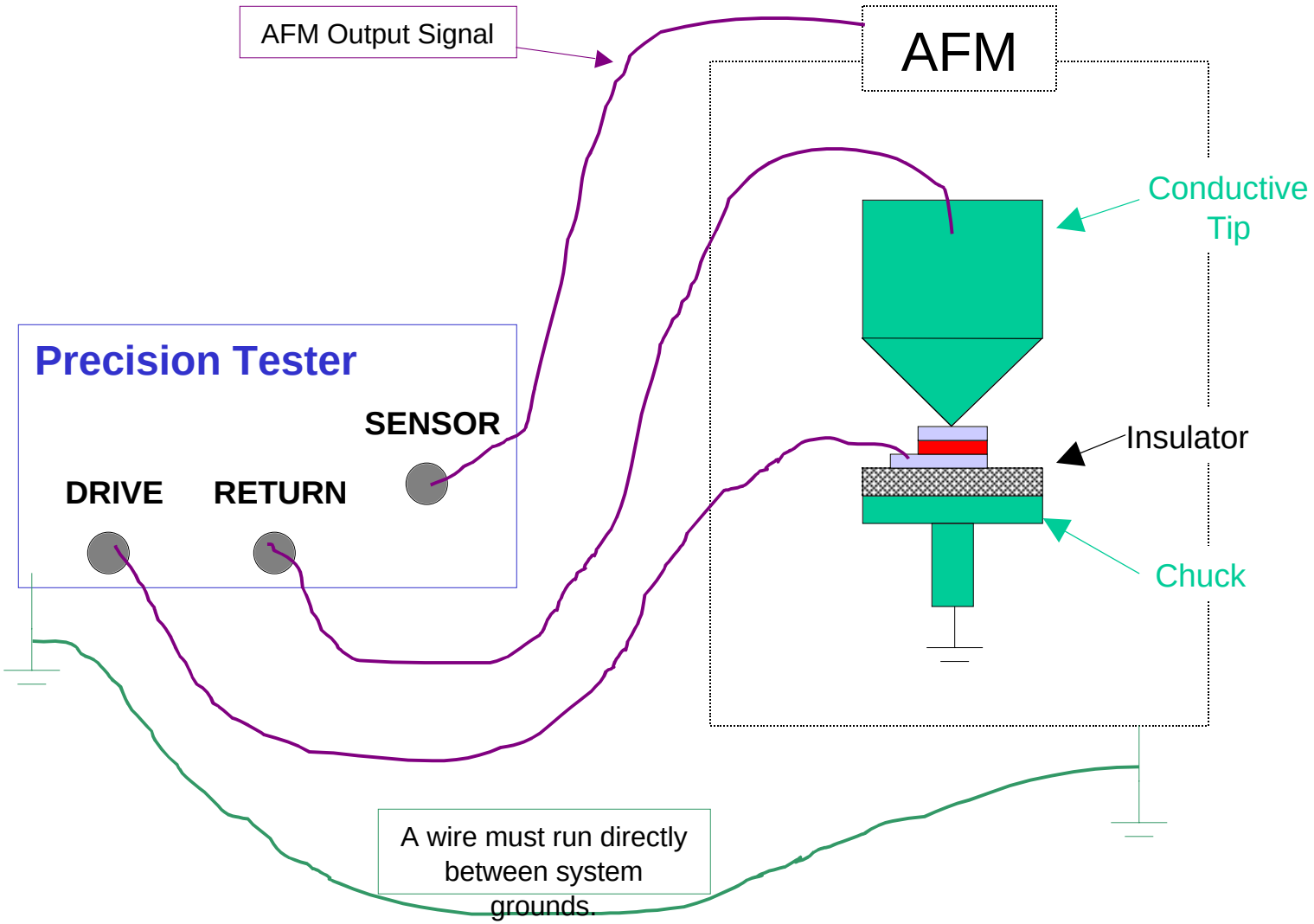
Limitations of Conducting AFM Probe Tips

- The use of the conducting AFM probe tip to contact the top electrode of the sample capacitor is very convenient, especially for small capacitors.
- During the switching phase of the hysteresis loop, the current density in the conductive coating of the probe tip is high enough to ablate metal off the probe tip. Consequently, conductive probe tips have a limited number of loops they can measure before all of their metal coating is ablated away.
- If hysteresis measurements are intermittent or contact cannot be made to the target electrode, the conducting probe tip should changed prior to looking for other problems.
- Slow test frequencies (i.e.1Hz) will significantly increase probe tip life time.

Noise

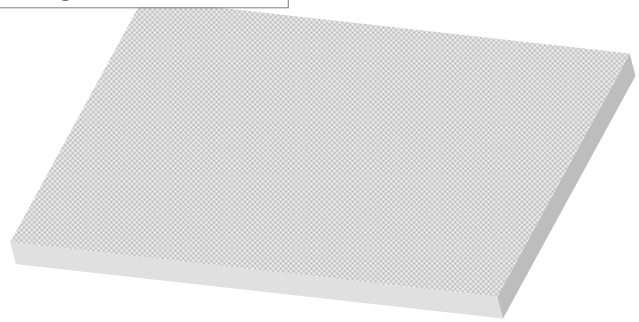
- Ground noise is a significant problem in AFMs. To minimize it, follow the instruction below.
  - Make the measurements with the AFM chuck grounded and the sample insulated from the chuck.
  - Make sure that the chuck is grounded to the rest of the AFM and then connect the AFM ground to the green ground plug on the rear of the Radiant Precision Tester.
  - If at all possible, connect the Radiant Precision tester to the same power outlet as the AFM.
- Other Noise
  - When a conducting probe tip is used, the connection runs through the AFM to the probe tip. This connection can pick up the high voltage fields of the AFM control system and thus will inject noise into the measurement. Use a conductive tip only if necessary.
  - When using a conductive tip, try the RETURN connected to the tip. If this is too noisy, reverse it and connect the DRIVE to the tip.

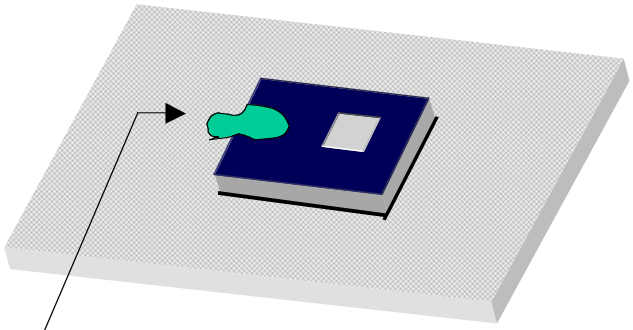
Connection Diagram



Sample Prep for Conducting Tip

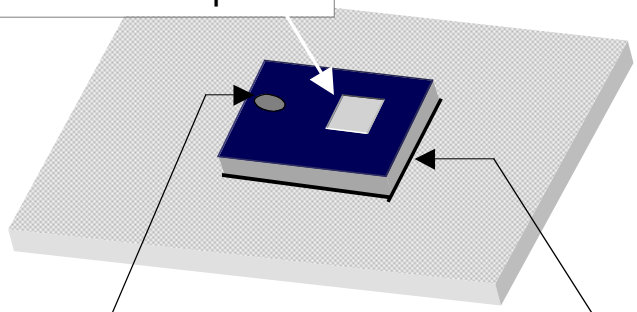
Silicon wafer with platinum or gold coating.





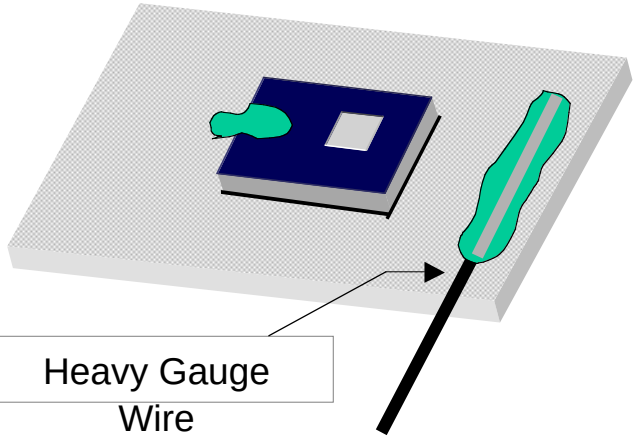
Nickel Print or Silver Print

Test Cap



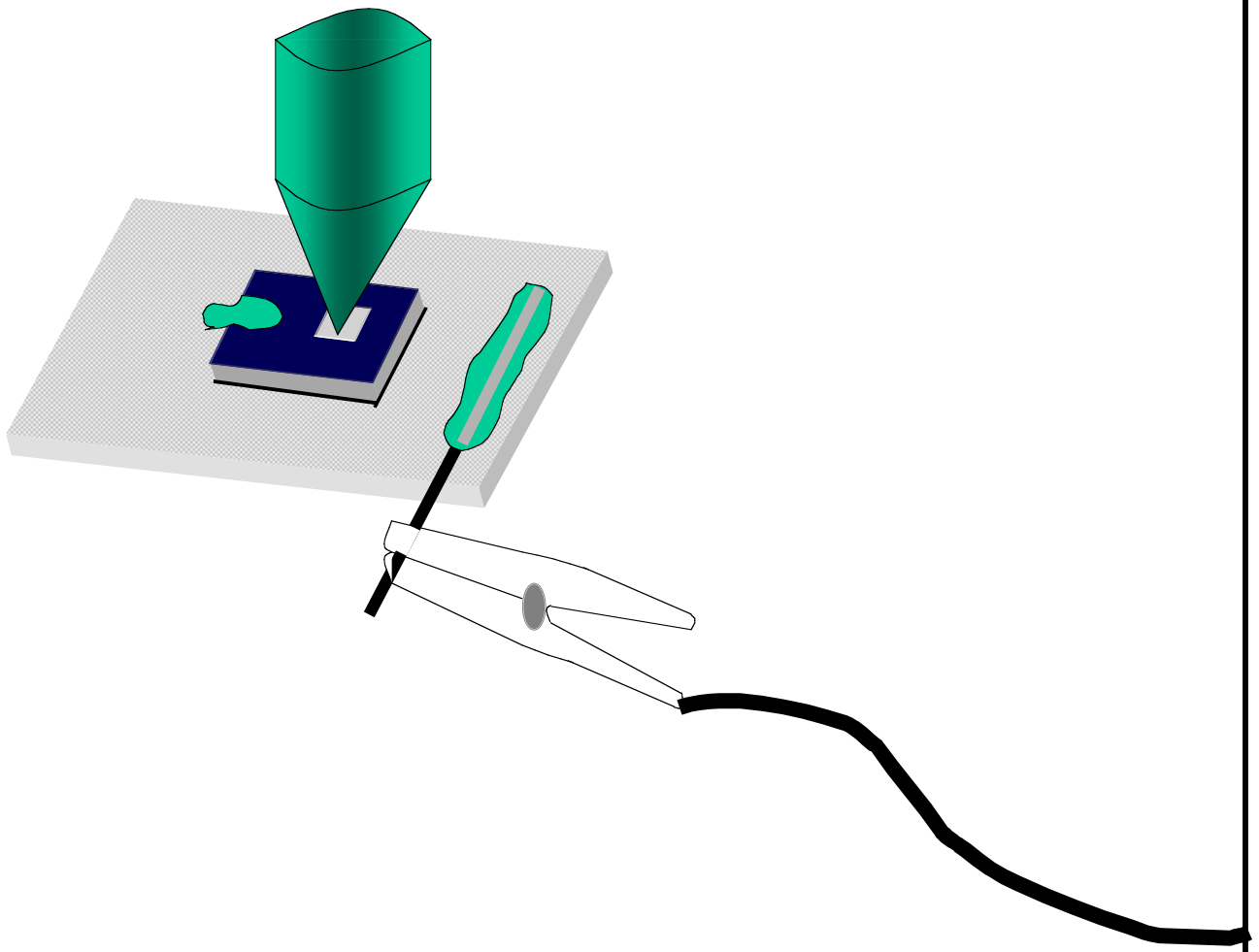
Etched Via to BE

Epoxy or Dried Photoresist

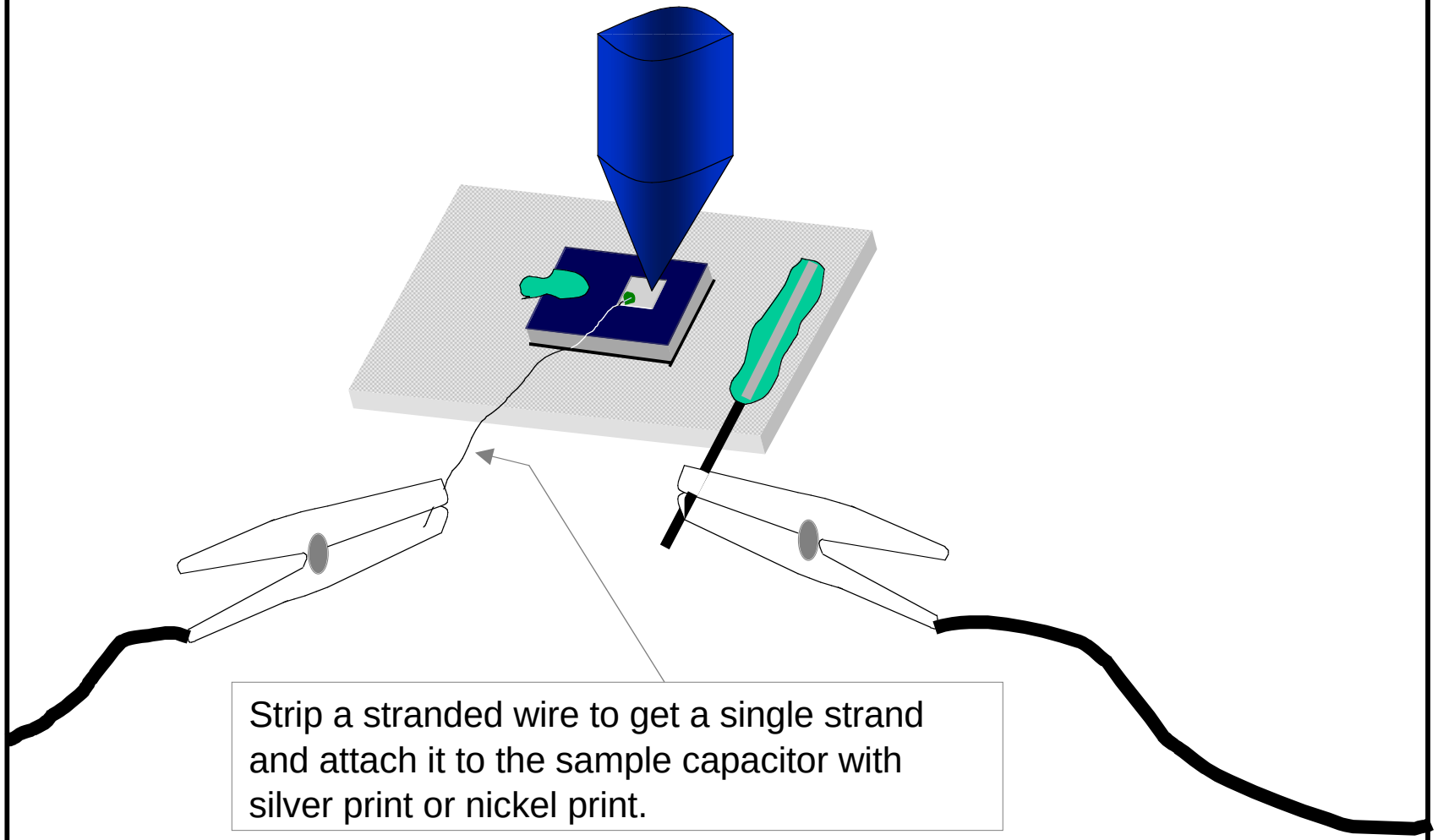


Heavy Gauge Wire

Using Sample for Conducting Tip



Sample Prep for Non-conducting Tip



Strip a stranded wire to get a single strand and attach it to the sample capacitor with silver print or nickel print.