

# **PicoLE Hydrogen Flame Annealing User's Manual**

**v1.0**

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## Hydrogen Flame Annealing Overview

MI gold substrates are produced by epitaxially growing high purity gold on green mica in a high vacuum. The resulting gold surface is  $\sim 2000 \text{ \AA}$  thick and composed of flat Au (111) terraces up to  $280000 \text{ nm}^2$ . Hydrogen flame annealing of MI's epitaxially grown gold substrates is extremely important for clean electrochemical work. Hydrogen flame annealing produces contaminant free reconstructed Au (111) surfaces.

### Safety Considerations

Hydrogen is a flammable gas that burns with oxygen to form water. The flame is bright and colorless. Make sure that all of the safety requirements are met before starting.

#### Equipment

- ◆ Pressurized  $\text{H}_2$  gas Cylinder
- ◆ Single stage high purity flow regulator
- ◆ Anti-flashback arrester
- ◆ Square quartz plate (approx. 5 cm X 0.5 cm thick)
- ◆ Small quartz piece (approx.  $1 \text{ cm}^2$ )
- ◆ Goggles or safety glasses
- ◆ Torch with a quartz tube narrowed to a fine tip with id less than 0.25 mm
- ◆ Teflon tubing
- ◆ Mask
- ◆ Gloves
- ◆ Tweezers

#### **Safety: Before starting make sure...**

- ◆ The regulator for the hydrogen cylinder meets the requirements for flammable gasses.
- ◆ The anti-backflash arrester is attached to the regulator.
- ◆ All flammable materials have been removed from the workspace.
- ◆ The work area is well vented.
- ◆ The goggles used offer adequate eye protection.

#### Procedure

1. Make sure the workspace environment is clean.
2. Place the quartz plate on the work surface, with the gold substrate on top. Make sure the "MI," that was scratched on the back of the substrate, is facing down.
3. Place the small quartz piece on the edge of the substrate to hold it in place.
4. Adjust the flow of the regulator to allow just enough hydrogen to pass to make a faint audible sound.
5. Turn off all the lights (the darker the room, the better).
6. Light the torch and adjust the flow of gas so that the flame is about 4 cm long.
7. Gently heat the quartz plate around the substrate to assure even heating. When water no longer condenses, it has been heated enough.
8. Bring the tip of the flame to the substrate at about a  $30^\circ$  angle.

9. Sweep back and forth (at approx. 1 Hz freq) for 30 to 60 seconds, keeping the small flame spot on the film a dim orange. If your room is not dark you will not see this glow and could burn your substrate, thus it is essential the room be very dark.
10. **DO NOT OVERHEAT** the film.
11. You will see the substrate bend as it is heated and then return to its original flat shape as it cools.
12. Blow out the flame and turn off the gas.
13. Let the substrate cool.
14. Remove it with tweezers.