

4ITM05 – Etching of AR surface to decrease reflectivity

Background

After remaining in storage for a lengthy period of time, the AR surface of this optic showed the buildup of a film that increased the reflectivity of the AR coating from the original specification of ~600 ppm to ~2400 ppm

In order to meet the interferometer requirements the AR coating was etched (cleaned) to bring the AR reflectivity closer to specifications.

Objective

The objective of this document is to detail the procedure used to achieve a lower AR reflection.

Etching solution

2000 ml DI water

20 ml Liquinox (then added an extra 20ml)

Temperature: 65° C

Stainless steel pan

The etching solution was made by mixing the ingredients cited above. The solution was stirred with a magnetic stirring bar while heating.

Procedure

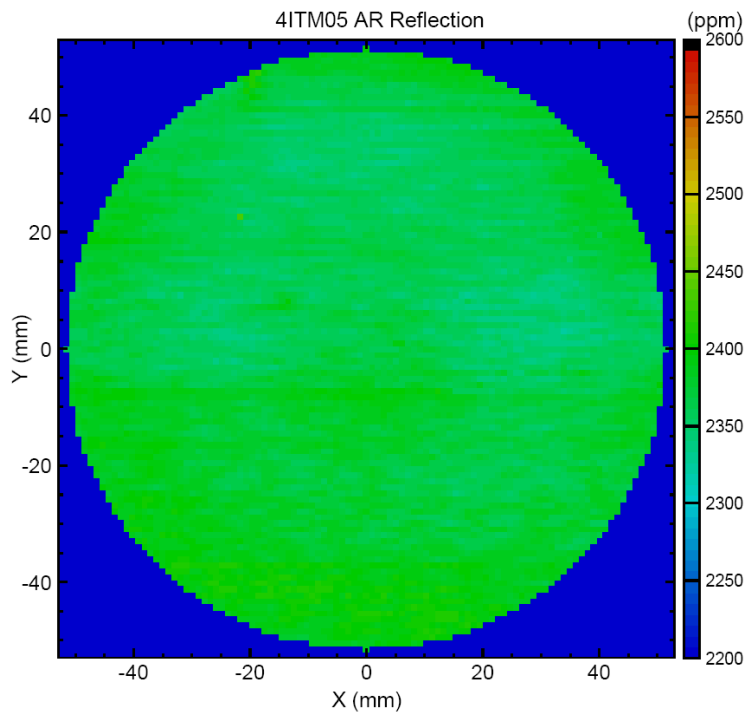
The mirror was held throughout the etching process with a ring with handles fasten around the edge of mirror. The substrate was resting on 3 Teflon (PFA) pieces inside the stainless steel tray. During the etching, the solution was continually agitated to prevent preferential etching.

After each etching step the surface was thoroughly rinsed under DI water and wiped dry with pure methanol.

Extreme care was taken to prevent getting the HR surface wet. If a drop of water was seen on the HR surface, it was immediately wiped dry.

In order to establish an etching rate, the AR surface was initially exposed to the hot Liquinox solution for 5 minutes.

At the start of the process the AR reflection was 2400 ppm. The surface was hydrophobic.



AR reflectivity before etching

1. First etch was to establish an etching rate

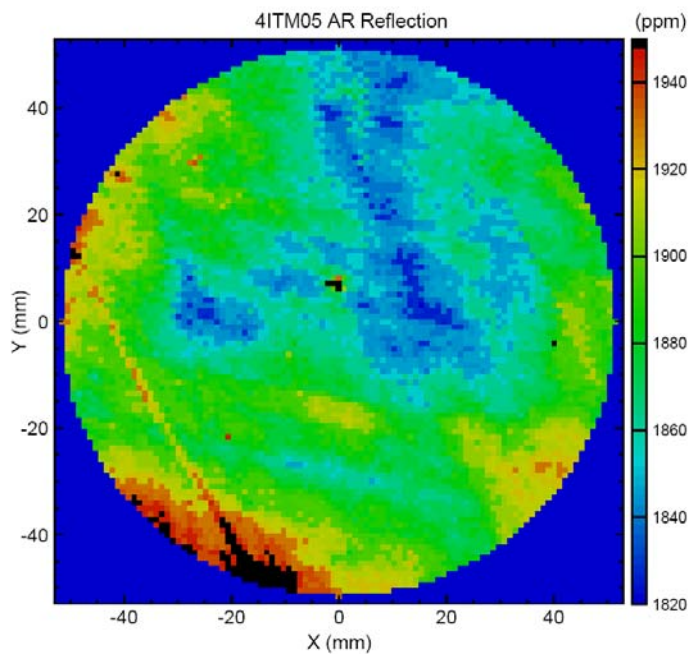
Immersed the coated AR surface in hot (65°C) Liquinox for 5 minutes.

AR reflection went down to 2300 ppm

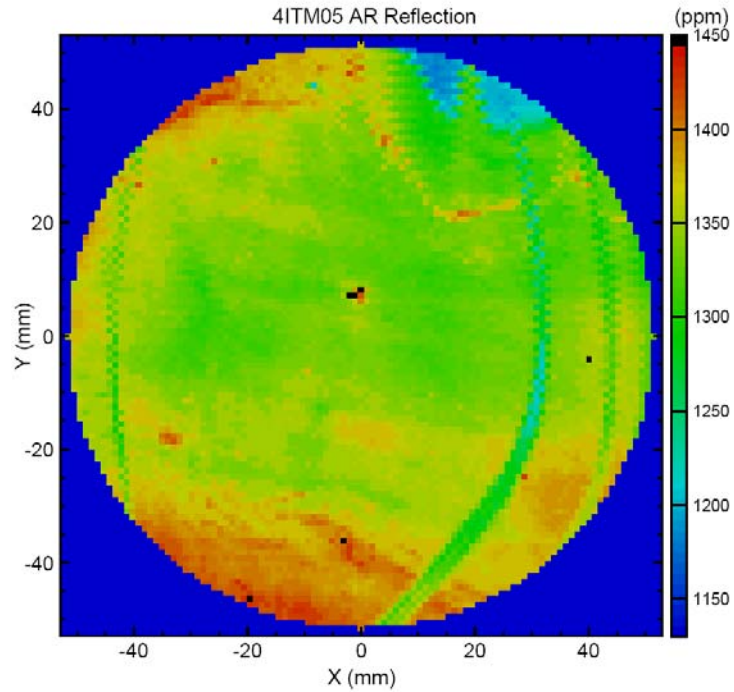
Added more (20 ml) Liquinox. The solution is now 2%

2. **Second etch;** left for 10 minutes; AR reflection was 2200 ppm

3. **Third etch;** left in the solution for 25 minutes; AR reflection was 1880 ppm.

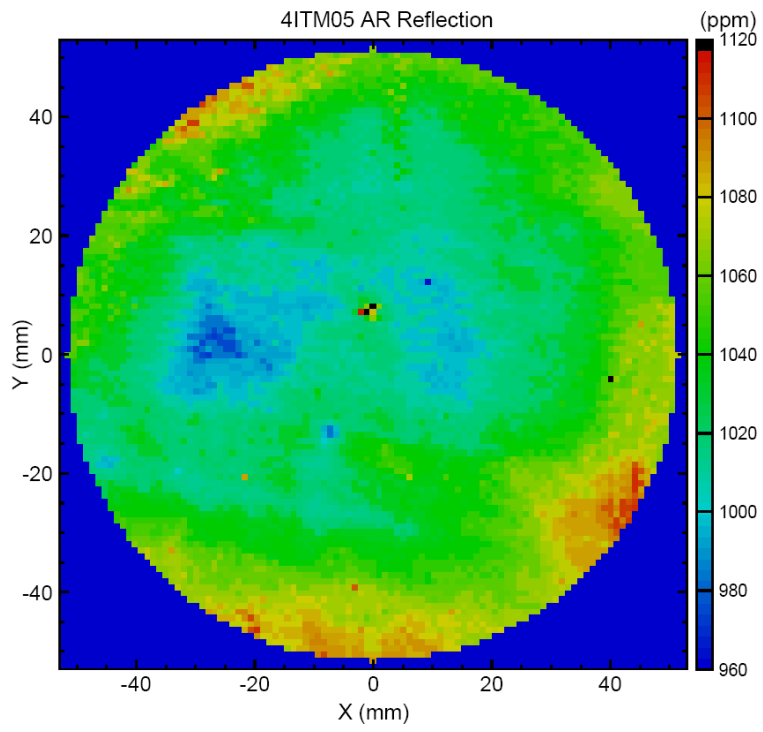


4. **Fourth etch.** Made a fresh etching solution. Etched for 15 minutes at 65°-68° C AR reflection went down to 1500 ppm. At this time the water was sheeting off the mirror's surface; the surface became hydrophilic.
5. **Fifth etch.** Etched for an additional 20 minutes at 68° C. Cold DI water was added to the solution to bring the temperature down in order to remove the mirror from the tray by hand since the ring holder was failing, slipping from the substrate. The AR reflection was 1350 ppm



AR reflectivity after 5th etch

6. **Sixth etch.** Made a fresh etching solution. Etched the AR coating for 20 minutes at 65° C.
The holding ring failed once again, even after adjustment, and was slipping off the mirror.
Added water to cool the solution and remove the mirror from the tray by hand.
AR reflection was ~1,000 ppm



AR coating reflectivity of the optic as delivered to Hanford