Process Notes: Etch Rates

Etch Rate:

How fast your material will be etched over time**.**

The question of how fast does a recipe etch away some material is a common question. To get the best results you are encouraged to do your own etch rate if your process needs exact etching to be done. For example, you are stopping your etch on a thin layer and do not want to etch into it very much.

NFC provides some basis etch rates on the Etch Rate chart. Note: these are typically done on non-patterned single wafers with only 1 wafer loaded. These etch rates are a guide only. You can use these if your process has a lot of room for variation

Etch Rate Variation:

Even if one person knows the rate, the exact value might be different for another design due to feature size and the thickness needed to be etched. The number of wafers being etched also slows down the etch rate. Even repeating the same etch with the same sample on a different day might have varying results due to what was run in the etcher before. To minimize the variation, the user can condition the chamber and complete another etch rate test right before running.

Chamber conditioning:

The cause for one previous run to affect the next run is a condition called "SEASONING". These are a result of gas and etch byproducts altering the process chamber. Once this byproduct is in the chamber it will most likely reach a steady condition of built up material. The amount added to the chamber is equal to the amount being removed for that process only. The problem happens when a different recipe is ran in the etcher and byproducts can cause the process to be altered. The byproducts either can cause the etch to happen faster or slower. This problem is only short term, as the byproducts are used or changed by the next recipe the new byproducts become more of an influence in the process chamber. So to solve this seasoning problem you will need to condition the process chamber first before running the etch rate test.

To have the process chamber in a known condition you will need to do two things.

One, clean all the past byproducts from the system, this is done by running the O2CLEAN recipe, a 30 min amount of time might be enough, you will have to decide.

Two, start having the recipe you will be using put byproducts into the chamber and have enough so the amount is stabilized. The amount of time needed is an unknown one since your process might not be the same as others. Also the reaction of the process recipe to a wafer coated with resist might be different to one without resist. So if your process is to be done on a resist coated wafer, then use a wafer with the same type of processing done to it.

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How the etch rate is done:

Start with a film that is to be the same type as you will be processing. Measure the initial film thickness. Most films can be measured using the nanospec or the Ellipsometer in Bay1.

The sequence is to have a film and measure it, the more measurements across the wafer the better. Then you etch the wafer, doing as much time as you can without removing the film, leave some film on there. Then re-measure the remaining film. Get the delta in film etched away and divide this by the amount of time. Example: Started with 5000 Ang oxide etched for 5 min. ending thickness was 1000 Ang. The delta is 4000 Ang / 5 min is equal to 800 Ang/min.

If you are looking to etch a thick amount, then knowing the rate for such a thickness is needed. For thinner films this can be harder, but starting out knowing the etch rate of a thicker film is a good starting point. Example, if I needed to etch 4000 Ang. of nitride the amount of time most likely would be several minutes while a 250Ang film would be less then 1 min. Putting a layer in and etching is for a few seconds is not very accurate etch rate. The etch rate might be high or low the first minute and after the second and third minute the etch rate most likely will be constant from then on. To solve the question of if the etch rate is faster or slower the first minute is to do more than one etch rate test. Do one for longer time and then another one for short time and see if it is linear or not during this time. You can see if the short amount of time has a higher or lower etch rate then the longer time.

One of the reasons the etch rate may change in the first minute is the film might have an oxidized layer on the surface and while this is being etched away it would slow the etching down.

Doing an etch rate on the layer below the film being removed might also be useful, this way you will know how much is being removed during the process.