Student staff - training by etching

The use of etch tools used in teaching semiconductor processing principles to our undergrad students

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MNC student staff information

MNC has 6 to 8 undergrads students working through out the year, doing simple stocking, cleaning, and packaging up hazardous waste.

This has been going on for over 25 years. (over 60 students during that time)

Most are science majors, freshman are preferred due to the amount of time needed for training them.

After the first 6 months to a year they learn basics including handling Haz waste disposal. The first task to uses equipment is LPCVD test wafer recycling.

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The student staff will learn several tools and help perform deposition rate checks, etch rate tests, and other helpful tasks.

During their senior year they are working on a project that will benefit MNC. There is also a side benefit too, as they have something talk about during interviews. When the student brought up the project during an interview, it
was a turning point. Several student said that is what got them the internship.

Some of the students will continue to work in the semiconductor field, or go on to grad school after working for us.

They are able to build on engineering skills - Most of the tasks they do will have a good base to build from. We allow them to fail or try doing something in a different manner.

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Beginning steps of learning equipment and working with wafers.

LPCVD LSN wafers get too thick if they are used too long.

The process dep rate changes with bare wafers V.S. nitride covered wafers.

Deposition test runs are done with the recycled LSN dummy wafers.

These bare dummies do the same thing what a full run of new bare wafers would.

The nitride is dry etched off of the surface and later sulfuric cleaned.

Tools the students learn to run: STS RIE, Thin film measuring tool, Wet chemical acid cleaning, and basic wafer handling.

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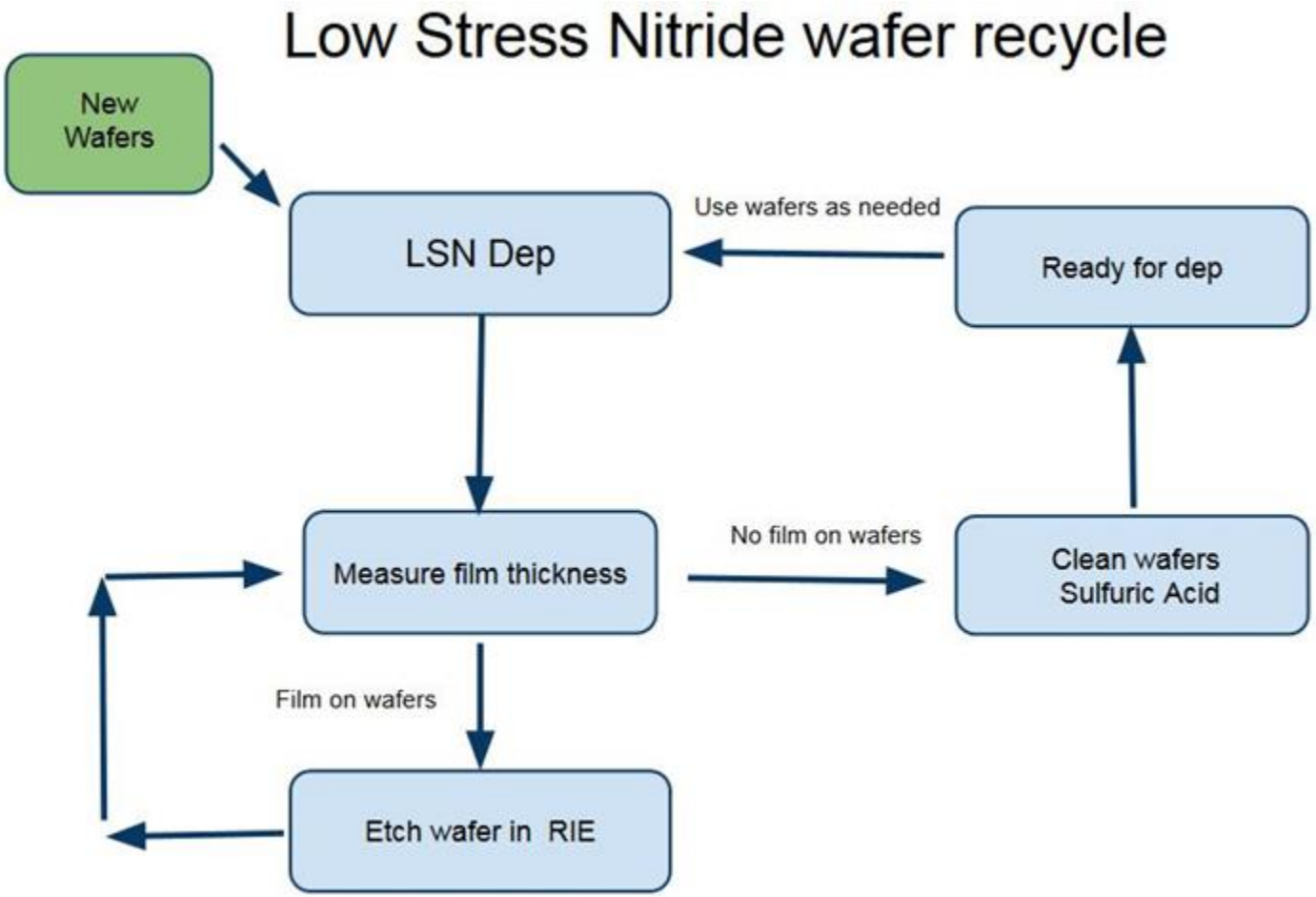

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There is a cost savings in recycling the wafers, but it allows the students to repeat etching and measuring. This develops proficiency and familiarity in using the tools. Students have freedom to plan/set work flow & schedule.

I spend time one on one time with students going over basic etching theory. These one on one talks continue over time with each new system or process.

These starting skills can be called on anytime for any future needs.

From this point students focus into one of these areas, ALD, Photo, PECVD, or Etching.

They are not set forever, but the next phase of a more deeper learning will be on a few limited tools. This happens during their second year or third year if they do not work during the summer and only work limited hours.

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MNC student staff have basic duties to do while working projects and need to plan
their workload

New chemicals to be put away

Haz waste still needs to be processed

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The undergrads students will reveal their natural cleanroom ability or prefer to work outside. One of a few things that we hope they discover about themselves.

The next step the student learns is to do etch rates, they already know the needed equipment, which builds confidence

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The skills can be directly used to do periodic etch rates. They do the easier systems to run and work up to the more complex etching systems.
STS or AV then DRIE lastly Oxford. Most etch rate tables are from student staff.

AV Etcher Etch Rates for 2015 - (Å/min.)

Films	PECVD Nitride-340	PECVD Oxide-340	Thermal Oxide	Low Stress Nitride	Regular Nitride	Resist 1813	Resist 1818	Resist NR71 1500P	Resist NR71 3000P	Bare Silicon Wafer	
Recipes										*PR mask*	*Al2O3 mask*
Nit1	2185	330	311	564		626	580	677	712	2518	2301
Nit2	1450	131	117	333		253	256	296	368	630	1525*
Nit3	983	39	37	98		116	100	107	145	442	881
Fastpoly	2066	148	110	316		430	445	477	488	6821*	7161*
Pjsnitd1	1365	448	405	890		706	800	737	830	4399	6424*
Slowpoly	608	28	33	45		102	91		143	1086	1240
Tyb-test	(312)	43	50	0		16	13	35	128	0	42*
Pjsoxide	109	250	196	53		63	41	58	160	25	71
O2-clean						1106	1345	1052	978		

Note: All etch rate tests were performed with a whole 4" wafer, after a 10 minute O_2-clean and a 5 minute chamber seasoning

*Resulting etched Si features show varying degrees of 'grass' or micro-masking.

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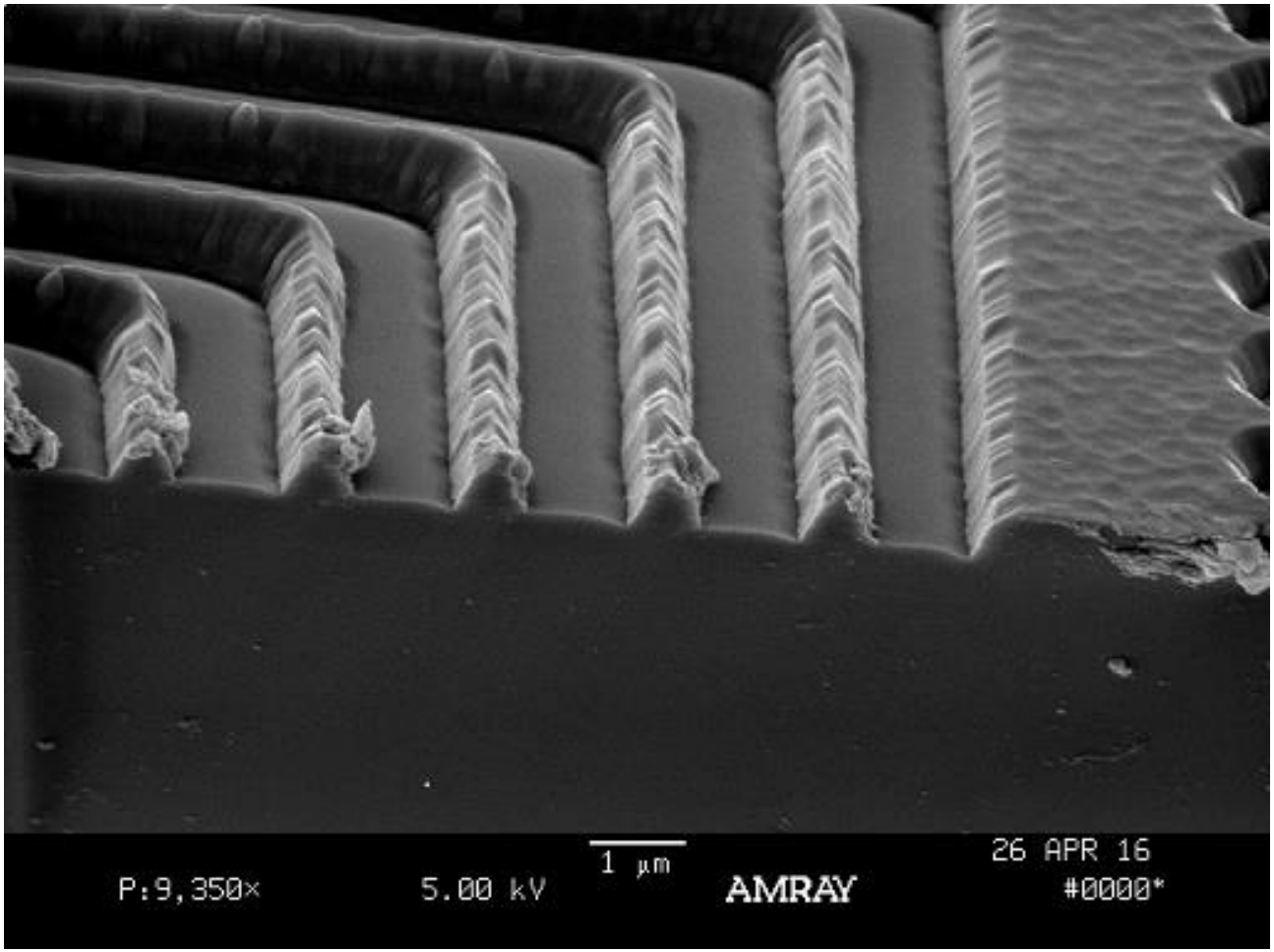
SEM images give feedback to the students allowing faster cycles of learning.
What was good or bad and what needs to be improved? (where is the resist ?)



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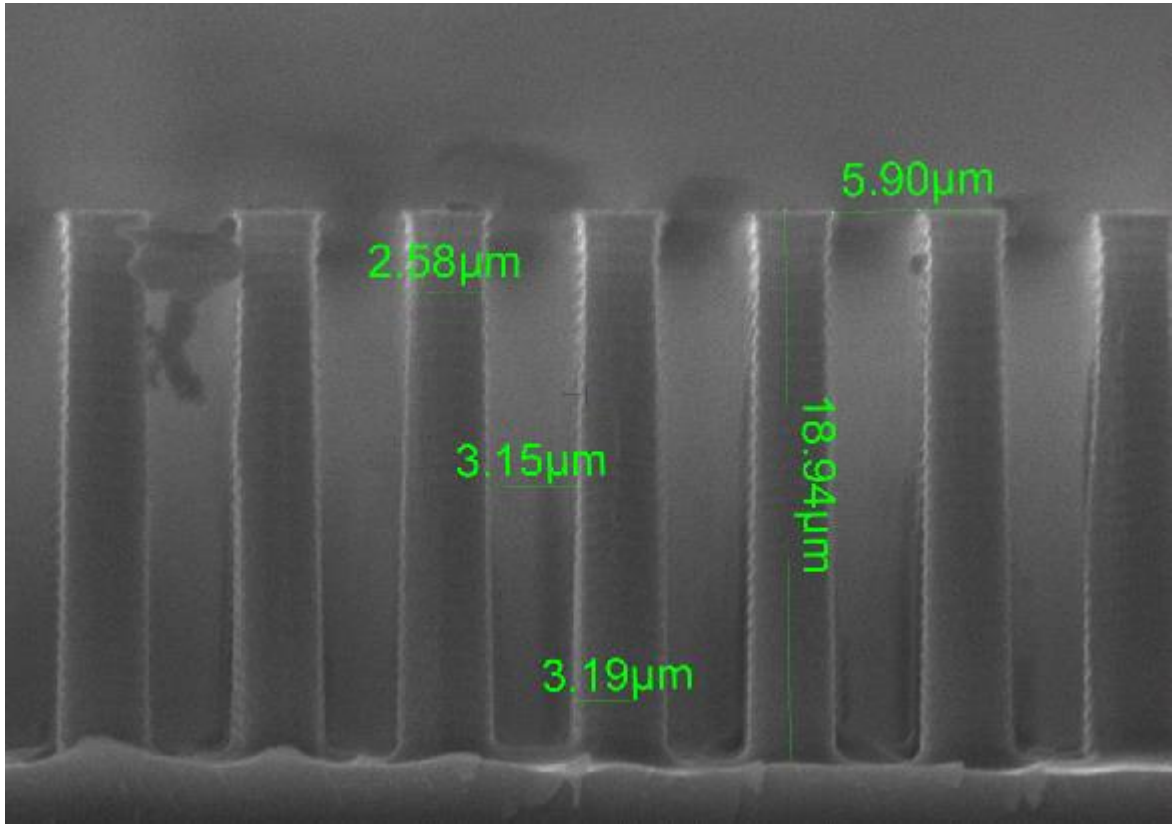
Etching results are inspected by SEM. The students learn basic SEM skills but also need to know what to do with the results. This gives clues to etch profiles and better understanding of etching.
They also confirm tool performance as needed.



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Senior projects – we allow them to plan the best method of doing research or setting up a process.

They also have some testing/research they largely controlled and written up (with hints that it should look like a peer reviewed publication)

These final projects are written up and included with equipment knowledge we have for the tool, or is handed out for given process applications.

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Aluminum Oxide Etching in TRION II

By Brett Sevenich

Glass Etching In A Trion RIE With ICP

Mark Landman-NanoFabrication Center, University of Minnesota

The Effect of Nitrogen Gas on Etching Nitride and Polysilicon

Amy Schendel

An Improved Etching Process Used for the Fabrication of Submicron Features in Niobium Lithography Masks.

August Lentsch- Nanofabrication Center, University of Minnesota

Solar p-i-n Cell

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