Installation and Operation of an Inductively Coupled Plasma (ICP) Etcher

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Project Objectives

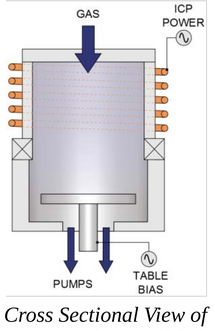
- Gain an understanding of the benefits of ICP etching over other etch methods
- Design a timeline of a tool installation in a cleanroom
- Decommission the PE 2400 Sputtering System
- Relocate and Reinstall CVC Thermal Evaporator
- Install ICP Etcher, Auxiliary Equipment

Motivation

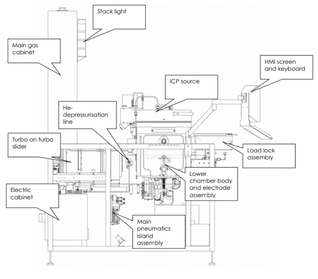
- New ICP Etcher acquired by Dr. Jing Zhang for use on GaN substrates in her group's research
- ICP Etching on III-V substrates presents a new capability not previously available at the RIT SMFL (Current use of LAM 4600 Reactive Ion Etcher (RIE) for etching on Si)
- Tool installation experience will be relevant to student's full-time employment

ICP Etching

- Dry etching method using bombardment of wafer surface with plasma of ions and radicals to remove material
- Preferable over wet etching due to ability to etch anisotropically and ability to achieve smaller dimensions with greater definition
- Process gases are accelerated through a spiral coil tube by its creation of an electromagnetic field, creating a plasma
- Plasma bombards the wafer surface in a separate chamber with electrostatic shielding, protecting the wafer from the electromagnetic field
- High density of plasma, process chamber under low pressure
- Volatile byproducts are vented away from the chamber



Cross Sectional View of an ICP Etcher Coil [1]



Cross Sectional View of Plasmatherm Apex SLR ICP Etcher components [2]

Plasmatherm Apex SLR ICP Etcher

ICP Etching Auxiliary Equipment

- Gas Reactor Cabinet (GRC) provides abatement of hazardous gases by reactions that form ionic salts
- Large water-cooled chiller provides a self-enclosed cooling water loop to tool, auxiliary equipment, with higher resistivity than building facilities loop
- Small chiller provides thermal fluid cooling to ICP Etcher electrode
- Roughing pump evacuates process chamber to create rough vacuum conditions

SMFL Equipment Preparation

- Available locations in SMFL surveyed for ease of access, minimal amount of other tool relocations, reduction of hazardous gas lines
- PE 2400 sputtering system decommissioned, removed from building facilities loops, and prepared for removal from SMFL
- CVC Thermal Evaporator moved, facilities loops recreated in new location
- CVC Thermal Evaporator internal wiring, plumbing overhauled and refurbished prior to reinstallation
- CVC Thermal Evaporator, auxiliary equipment reinstalled and prepared for use in new location

PE 2400 Sputtering System [3]

CVC Thermal Evaporator

Tool Installation

- Facilities needs assessed, tie-in points found
- Nitrogen lines in service chase relocated, new gas regulator panel created
- Large chiller found in inventory, reservoir and wiring refurbished for use

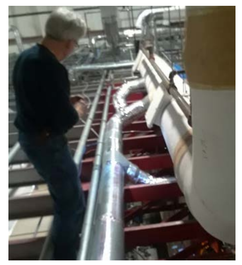
New nitrogen regulator panel

Refurbished large chiller

Tool Installation (Cont.)

- Electrical disconnect boxes installed, wiring from circuit breakers to contactors and contactors to equipment created
- Exhaust design created for minimal elbows, measurements and locations taken
- Hazardous gas line work sent for quote
- Cooling water loop needs laid out, preliminary manifold-based designs in progress

New contactor wiring in progress



Surveying exhaust connection locations

A cooling water loop manifold

Conclusions

Future Work

- Finish tool cooling water loop
- Finish tool exhaust lines and connections
- Create process gas lines to tool, hazardous gas cabinet
- Run DOE on tool/Work with preset manufacturer process recipes to characterize tool
- Complete abbreviated user's manual for day-to-day use

References

1. "Inductively Coupled Plasma (ICP) Etching." Oxford Instruments, www.oxford-instruments.com/products/etching-deposition-and-growth/plasma-etch-deposition/icp-etch
2. Advanced Vacuum Apex SLR ICP Installation Guide and Users Manual
3. http://www.semistarcorp.com/product/perkin-elmer-2400-sputtering-system/
4. Quirk, Michael, and Julian Serda. Semiconductor Manufacturing Technology. Pearson Education Taiwan, 2008.

Acknowledgements

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