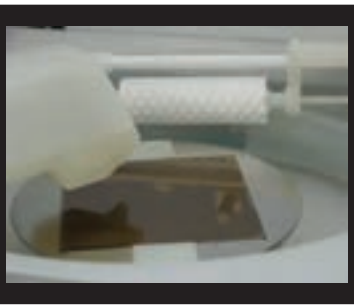
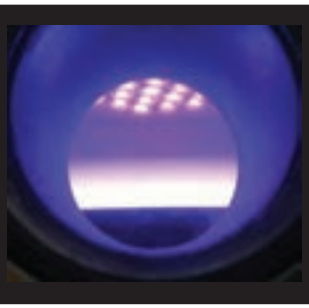
Single Wafer Thin Film Processing Systems

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About Us

NANO-MASTER, USA was founded in 1992 as a wholly-owned subsidiary of NANO-MASTER, S.A., France, a leading metrology company in defect inspection and high speed overlay measurement. Subsequent to the closing down of Nano-Master S.A. in 1993, Dr. Birol Kuyel took over the ownership of NANO-MASTER, USA. The name was changed later to NANO-MASTER, Inc., which has now become a 100% privately owned US company.

NANO-MASTER started design and development of research tools in 2001 and focused on thin film applications. The first tool was a Sputtering System followed by a PECVD System and later a Wafer Cleaner System was delivered.

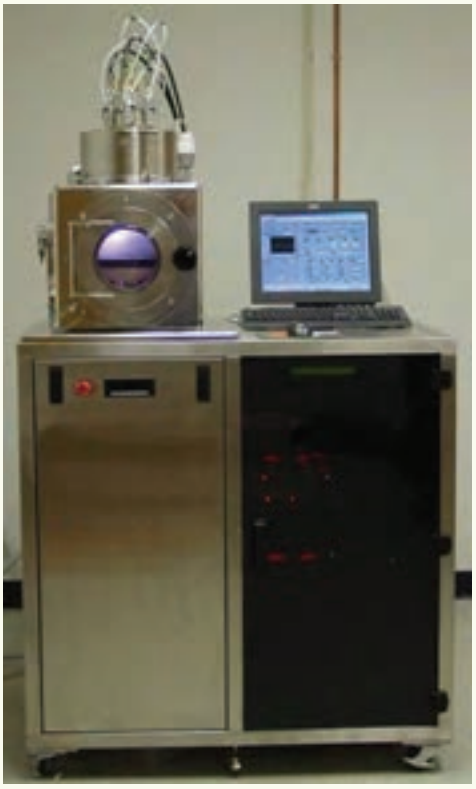
NANO-MASTER products are used in LED, MEMS, Optoelectronics, Nanotechnology, Photovoltaic, Semiconductor, and Space Simulation applications. Some of the products are PECVD Systems for deposition of SiO_2, Si_3N_4, DLC and CNT; PA-MOCVD Systems for InGaN and AlGaN; Sputtering Systems (reactive, co-sputtering, combinatorial); Thermal and E-Beam Evaporators, Ion Beam Milling and Reactive Etching Systems; Atomic Layer Deposition and Atomic Layer Etching Tools; Thermal Vacuum Systems; Megasonic Cleaning Systems and Photoresist Stripping Equipment.

NANO-MASTER has established itself as a thin film equipment supplier around the world and sold over 150 units in thirty countries primarily to universities, research centers and leading national laboratories.

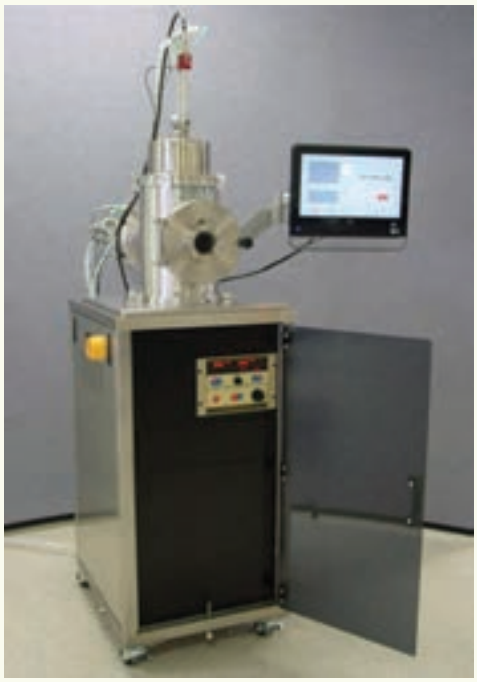
Birol Kuyel, Ph.D. is the president and CEO of NANO-MASTER, Inc. His background expands to broad range of technologies including High Temperature Plasma Physics, Turbulence, Si_3N_4 Film Deposition and Characterization, X-Ray Source Development, DUV Source Development, DUV Step and Scan Lithography Tool Development (SEMATECH) and the Lithography Cost of Ownership Model (SEMATECH). He has been awarded 10 patents and published numerous papers.

NANO-MASTER employs highly skilled and educated design and manufacturing engineers, application engineers, service engineers and support personnel.

NANO-MASTER's objective is to provide top quality services while maintaining the highest levels of integrity at all times.



NSC-4000



NSC-3500

NSC-1000

Sputtering Systems

NANO-MASTER state-of-the-art fully automated Sputtering Systems come with water cooled or heated (up to 700 °C) rotating 8" platen and up to four off axis planar magnetrons. The system is pumped with a turbomolecular pump and achieves mid 10^{-7} Torr base pressure. RF or DC power supplies can be switched to multiple magnetrons by the use of an RF switch. Magnetron to substrate distance is adjustable in order to achieve desired uniformity and deposition rate. Rotating platen with off axis magnetrons provide means of achieving the best film uniformity. Crystal thickness monitor is provided for terminating process automatically.

Features:

- Stainless Steel, Aluminum or Bell Jar Chambers
- 70, 250 or 500 l/sec Turbomolecular Pump Backed with a Mechanical or Dry Pump
- 13.5 MHz, 300-600 W RF and 1 KW DC Power Supplies
- Crystal Holder with <1 Å Thickness Resolution
- Door with View Port for Easy Wafer Load and Unload
- PC Controlled with LabVIEW
- Multiple Levels of Access with Password Protection
- Fully Safety Interlocked

Options:

- Up, Down and Side Sputtering
- RF, DC and Pulsed DC Sputtering
- Co-Sputtering, Reactive Sputtering
- Combinatorial Sputtering
- RF or DC Bias
- Heated Platen up to 700 °C
- Thickness Monitor
- Substrate RF Plasma Cleaning
- Load Lock and Auto Wafer Load/Unload

Applications:

- Metal and Dielectric Coating of Wafers, Ceramics, Glass Blanks, Disk Heads
- Optical and ITO Coatings
- Hard Coatings with High Temperature Platens and Pulsed DC Power Supplies
- Reactive Sputtering with RF Plasma Discharge

Models:

NSC-4000	PC Controlled, Stand Alone System
NSC-3500	PC Controlled, Compact Stand Alone System
NSC-3000	PC Controlled, Table Top

Dual Systems:

NSR-4000	Sputtering and RIE System
NSP-4000	Sputtering and PECVD System
NST-4000	Sputtering and Thermal Evaporator System

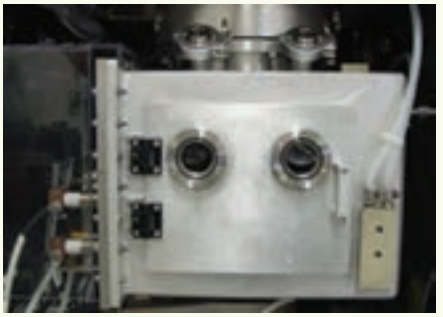
E-Beam Evaporation Systems

NEE-4000

NANO-MASTER NEE-4000 Electron Beam Evaporation Systems come in a dual chamber configuration consisting of the main chamber where platen is located and a secondary chamber for housing the e-beam source. This configuration with a gate valve between two chambers may be used as a load lock to keep the e-beam source pockets in vacuum while substrate is loaded and unloaded from the main chamber substrate holder or platen. On other applications where automatic loading and unloading of wafers is needed, it can be achieved through a third load lock chamber that may be attached to the left side of the cube. Co-Evaporation capability with multiple e-beam sources and ability to program compositions or compositional gradients through PC control can be provided.

Features:

- Sequential or Co-Evaporation
- Dual E-Beam Source
- Multi-Pocket E-Gun
- Programmable Beam Scan
- 10 KW Switching Power Supply
- Up to 8” Rotating Substrate
- ~15”-18” Substrate to Source Distance
- Turbomolecular Pump, $5x10^{-7}$ Torr
- Manual Load/Unload
- Auto Load/Unload with Load Lock
- Crystal Thickness Monitor
- PC Controlled with LabVIEW
- Recipe Driven, Password Protected
- Fully Safety Interlocked



E-Beam Housing

Thermal Evaporation Systems

NTE-3500

NANO-MASTER NTE-3000 table top and NTE-3500 compact stand alone Thermal Evaporator Systems are manufactured for wide ranges of applications for organic and metal evaporation. They are designed with extreme care to achieve clean, uniform, controllable and reproducible process on a small footprint. They provide at low cost, high quality and advanced capability to end users with demanding applications in R&D and low scale manufacturing. Thermal Evaporators operates either at a set RMS current or in a closed loop configuration and in this case the variation of the deposition rate is used to adjust RMS current to maintain constant deposition rates.

The NTE-4000 is a stand alone Thermal Evaporator System allowing more room for additional capabilities such as Co-Evaporation, Dual Evaporation and Sputtering capabilities.

Features:

- Up to 7”x7” Plates and 200 mm Wafers
- Controlled Deposition Rate
- Rotating Sample Holder
- Heated Platen
- Multiple Crucibles
- 2 KVA SRC Controlled Power Supply
- Crystal Thickness Monitor
- PC Controlled with LabVIEW
- Magnetron Sputtering

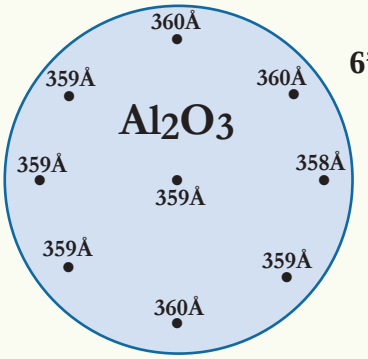
NTE-3000

Plasma Enhanced Atomic Layer Deposition System

NLD-4000

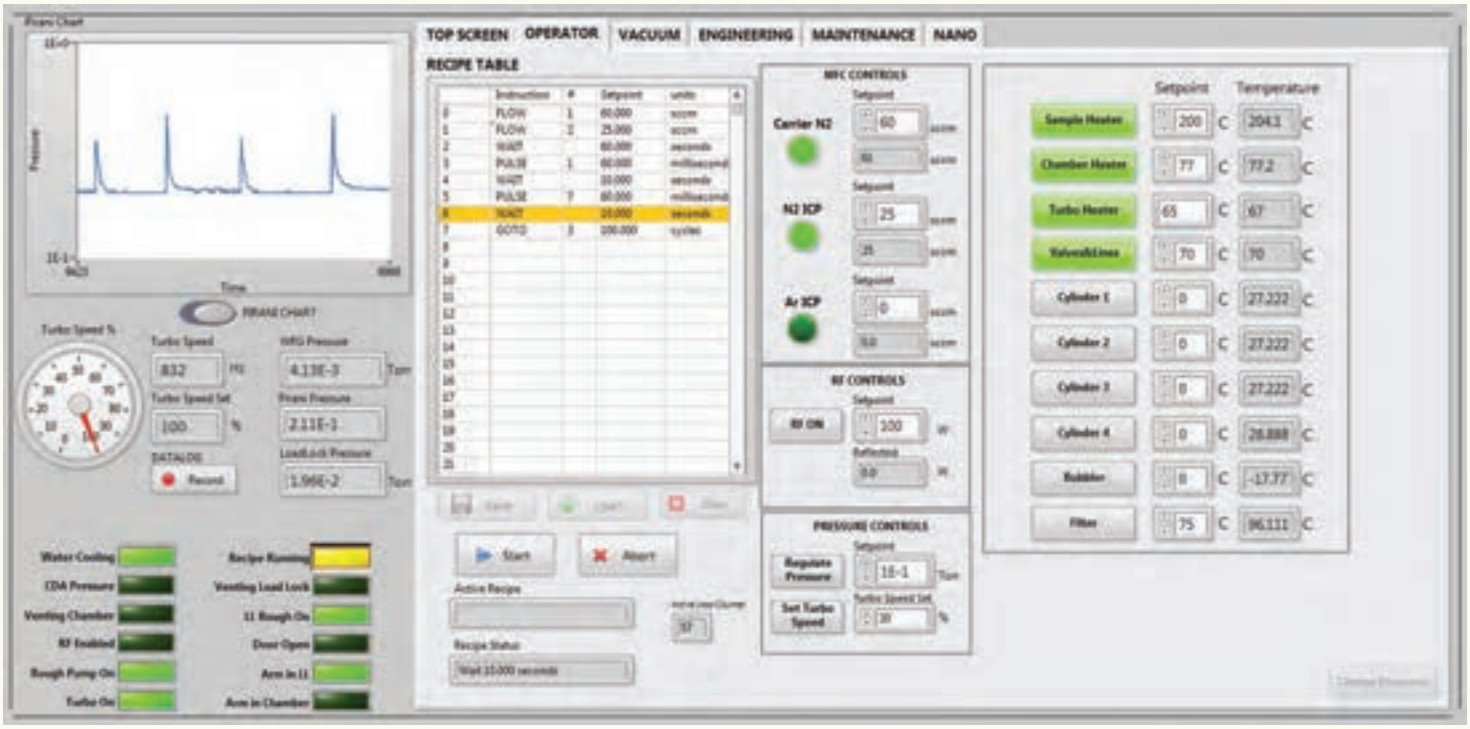
Features:

- Small Footprint: 28”x44”
- Fully Automated
- PC Controlled
- LabVIEW Software
- ± 1 Å on 360 Å Thick Al_2O_3
- Short Cycle Time
- Onboard Gas Pod
- 10^{-7} Torr Base Pressure
- Up to 8” Substrates
- Heated Platen up to 400°C
- Downstream ICP Source
- Auto Load Unload
- 300 l/sec Turbomolecular Pump
- Up to Seven 50ml Precursor Cylinders



6” Wafer

Cycle: 300 Cycles
(TMA + H_2O)
Uniformity: 0.27%, ± 1Å
Temperature: 200 °C
Refractive Index: 1.67



NLD-4000 Software - Automatic Recipe Mode

Reactive Ion Etching Systems

NRE-4000

The NRE-4000 is a stand alone Reactive Ion Etching (RIE) System with shower head gas distribution and water cooled RF platen. It has a stainless steel cabinet and a 13" cylindrical Aluminum chamber that opens from top for wafer loading. Chamber has two ports, one with a 2" window and the other with a blank off for diagnostics. It can accept up to 8" wafers. Chamber is extremely clean in design and reaches 10^{-6} Torr or lower base pressure depending on the pumping package. It can be operated in the pressure range of 20 mTorr to 8 Torr. Pumping package consists of a throttle valve, 250 l/sec corrosive turbomolecular pump, sieve filter, and a 10cfm mechanical pump with fomblin oil. The RF power is provided by 600 W 13.5 MHz power supply and auto tuner. The self DC bias is continuously monitored and reaches as high as -500 V which is important for anisotropic etching. The system is completely automated and is PC controlled. The real time system pressure and DC bias is displayed in graphic format while flow and power is displayed in alpha numeric format. Four levels of password protected access: Operator, Engineering, Process and Maintenance. Allows running the system in semi-automatic mode (Engineering), writing recipes (Process) and executing recipes automatically (Operator).

NRE-3500

Features:

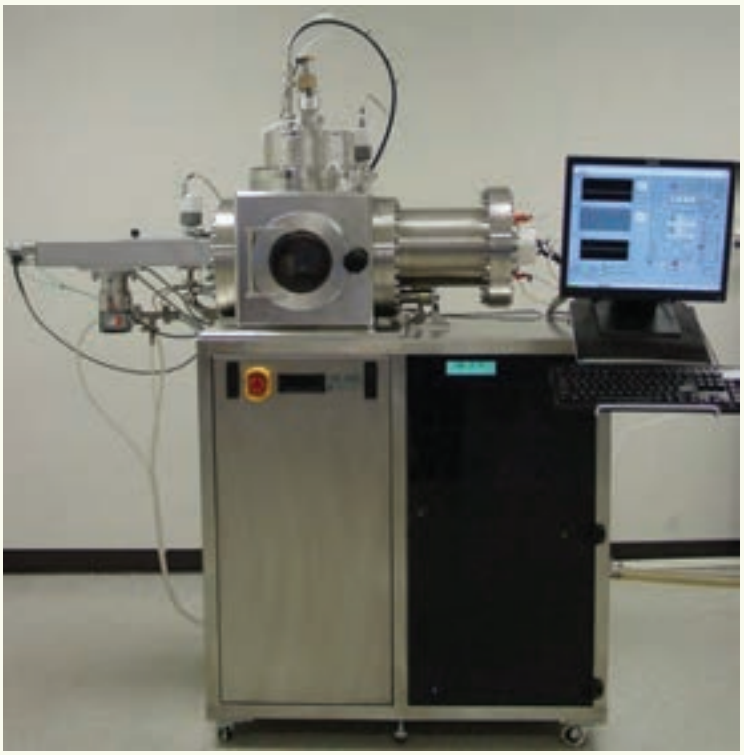
- Aluminum or Stainless Steel Chamber
- Stainless Steel Cabinet
- Capable of Etching Si Compounds (~400 Å /min) and Metals
- 8" Anodized RF Platen
- Water Cooled and Heated RF Platen
- Large Self Bias
- Shower Head Gas Distribution
- ~ 10^{-6} Torr < 20 minutes, ~ $5x10^{-7}$ Torr Base Pressure
- Turbomolecular Pump
- Up to Four MFC's on NRE-3000 and up to Eight MFC's on NRE-4000
- No Flexing of Gas Lines
- Down Stream Pressure Control
- Dual Etch Capability: RIE and Plasma Etch
- End Point Detection
- Pneumatically Lifted Top
- Manual or Automatic Loading/Unloading
- Load Lock
- PC Controlled with LabVIEW
- Recipe Driven, Password Protected
- Fully Safety Interlocked
- Optional ICP Source and Cryogenic Cooling of the Platen for Deep Si Etch

NRE-3000

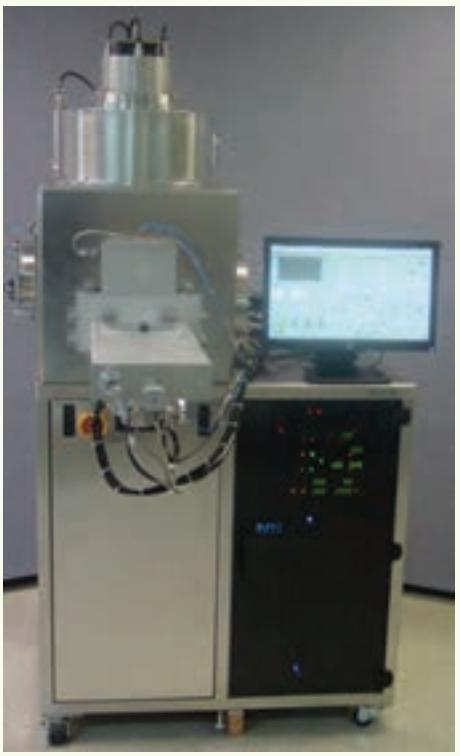
Models:

NRE-4000	Stand Alone System, 26"D x 44"W Footprint
NRE-3500	Stand Alone Compact System, 26"D x 26"W Footprint
NRE-3000	Table Top System, 26"D x 26"W Footprint
NRP-4000	Dual RIE / PECVD System
NDR-4000	Deep RIE System

Ion Beam Milling and Reactive Etching Systems



NIE-4000 Ion Beam Milling System with 6” DC Ion Source and Auto L/UL



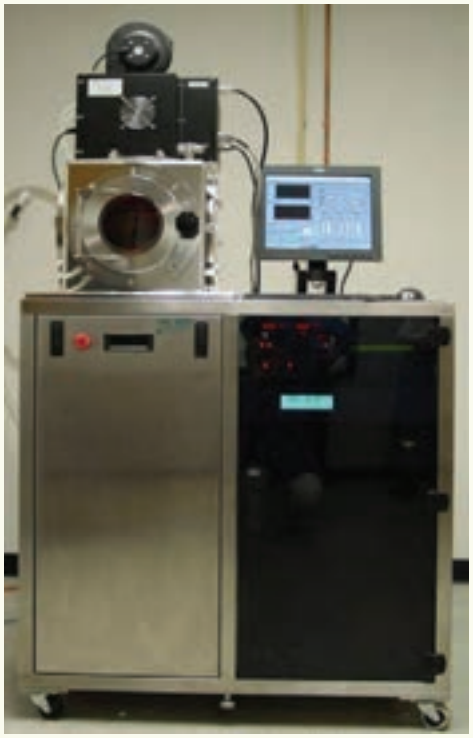
NIE-4000 Reactive Ion Beam Etch System with 8” RF Ion Source and Auto L/UL

Etching of metals which do not have volatile compounds such as Cu and Au cannot be accomplished in RIE Systems; however, physical etching or milling with accelerating Ar ions is possible. Typically, surface is patterned with thick resist for masking and the energetic ion flux during etching overheats the substrate and the resist. Unless efficient means of removing the heat is found, resist becomes very difficult to remove. NANO-MASTER technology has demonstrated capability of keeping substrate temperature below 50 °C while wafer is rotating to achieve the desired uniformity. NIE-4000 also comes with RF Ion Source for Reactive Ion Beam Etching.

Ion Beam Milling System Features:

- 14.5” SS Cube Ion Beam Chamber
- 12 cm DC Ion Gun 1000 V, 500 mA , DC Motor Driven SS Shutters
- Ion Beam Neutralizer
- Ar MFC
- Chilled Water and He Back Side Substrate Cooling
- Wafer Rotation 3-10 RPM, Vacuum Stepper Motor
- Wafer Tilt with a Stepper Motor through Differentially Pumped Rotational Seal
- Manual or Auto Wafer Load/Unload
- Typical Etch Rates: 20nm/min Cu, 50nm/min Si
- +/-5% Etch Uniformity over 4” Area
- $5x10^{-6}$ Torr < 20 minutes < $2x10^{-7}$ Torr (2 days) Base Pressure with 500 l/sec Turbo
- $8x10^{-8}$ Torr Base Pressure with 1000 l/sec Turbo Pump
- Magnetron Sputtering of SiN_4 to Protect Etched Metal Surfaces from Oxidation
- PC Controlled with LabVIEW Software
- Recipe Driven, Password Protected
- Fully Safety Interlocked

PECVD Systems



NPE-4000 for CNT

NPE-4000 for Si_3N_4 and SiO_2 Deposition

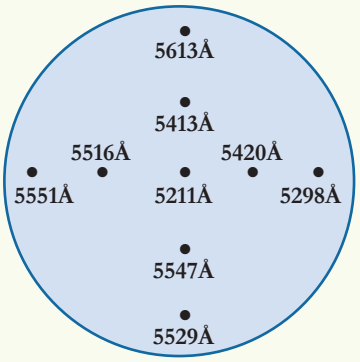
NANO-MASTER PECVD systems are capable of depositing high quality SiO_2, Si_3N_4, or DLC films on up to 8" diameter substrate size. To generate plasma, it uses RF shower head electrode or hollow cathode RF plasma source with fractal gas distribution. The platen can be biased with RF or pulsed DC and it is heated resistively or cooled with chilled water circulation. The chamber is evacuated to low 10^{-7} Torr pressure using 250 l/sec turbomolecular pump backed with 3.5 cfm mechanical pump. Standard unit comes with one inert gas, three reactive gas lines and four mass flow controllers. The planar hollow cathode plasma source with its unique gas distribution system makes it possible to meet wide range of requirements such as plasma density, uniformity and separate activation of reactive species to cover the broadest possible deposition parameters.

Features:

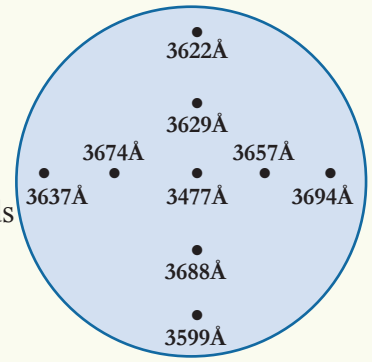
- Stainless Steel or Aluminum Chamber
- Vacuum 10^{-7} Torr Range Base Pressure
- RF Shower Head, HCD, ICP or Microwave Plasma Sources
- Up to 8" Diameter Substrate Holder
- RF Biased Substrate Holder
- Water Cooled Platen
- Heated Platen up to 800 °C
- Heated Gas Lines up to 130 °C
- Heated Liquid Delivery System
- Corrosive Pump Package
- Pneumatically Controlled Valves
- PC Controlled with LabVIEW
- Recipe Driven, Password Protected
- Fully Safety Interlocked
- One Carrier Gas and Three Reactive Gases
- PC Controlled Mass Flow Controllers
- Up to 8 MFC's with Vented Box and Gas Manifolds
- Load Lock and Auto Wafer Load/Unload

Applications:

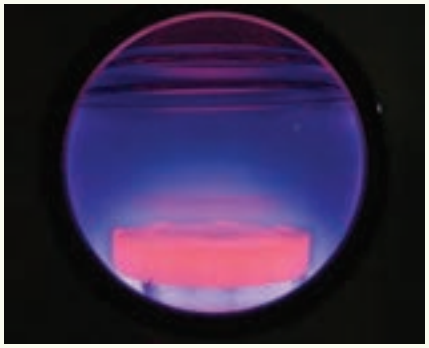
- Plasma Induced Surface Modifications
- Plasma Cleaning
- Plasma Polymerization
- SiO_2, Si_3N_4, DLC, other Films
- Selective Growth of CNT and Graphene



Silicon Dioxide
Wafer Size = 6"
Tc (°C) = 200 °C
Uniformity % = 3.6%
Refractive Index = 1.48

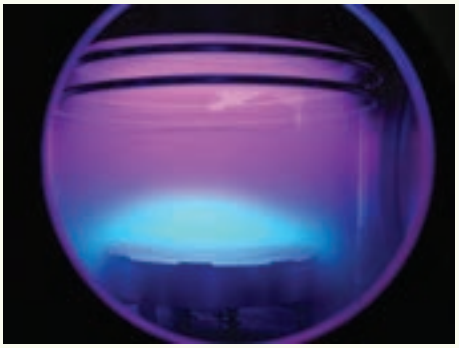


Silicon Nitirde
Wafer Size = 6"
Plate Temp (°C) = 230 °C
Uniformity % = 2.9%
Refractive Index = 2.03



-500 V Bias, 700 °C, ICP Off

300 W RF Bias



-1000 V DC Bias, 500 °C, ICP On

Plasma Assisted MOCVD Systems

NANO-MASTER has developed the first Table Top Plasma Assisted Metal Organic Chemical Vapor Deposition (PA-MOCVD) System for InGaN and AlGaN deposition processes. The features include five bubblers with individual cooling baths, heated gas lines, 950 °C platen, three gas rings, RF plasma source with shower head gas distribution and N_2 flush at the end of the process, $5x10^{-7}$ Torr base pressure, 250 l/sec turbo pump with oil-free scroll pump, PC controlled, fully automated and safety interlocked. Plasma assistance allows deposition of GaN, InGaN, AlGaN films at lower process temperatures (700 °C).

This technology has been extended recently to 6" wafer stand alone system which can be integrated into a cluster configuration to meet high throughput production needs.

NMC-3000 TableTop System

- Application: Green LED's (GaN, InGaN, AlGaN)
- 950 °C Platen, 2" Wafer
- $5x10^{-7}$ Torr Base Pressure
- Five Bubblers: Precursors for In, Ga, Al and Two Dopants
- PC Controlled with LabVIEW
- Recipe Driven, Password Protected
- Fully Safety Interlocked

NMC-4000 Stand Alone System

- 14.5" Stainless Steel Cube Chamber
- One 6" Wafer with 8" Platen or Five 4" Wafers on 12" Platen
- RF Plasma Source with Auto Tuner
- 950 °C Rotating Platen
- Manual or Automatic Wafer Loading and Unloading
- Compatible with Cluster Configuration

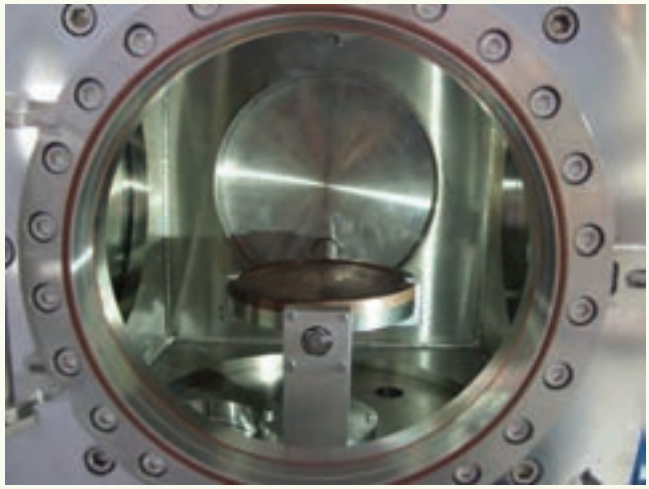
Optical Coating Systems

Applications:
- Optical Coatings
  - Sputtering
  - IBAD
- Reactive Ion Beam Etching Cleaning
- Ion Beam Milling
- Infrared Coatings
- Surface Treatment

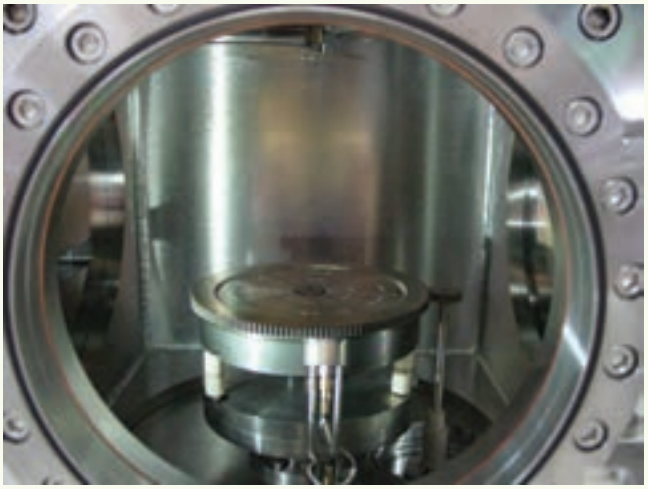
Features:
- RF Biasable Platen
- Thickness Monitor
- 5 10^{-7} Torr Base Pressure
- High Accuracy and Repeatability
- High Quality Films
- Atomic Level Clean Surfaces
- Atomic Cleaning and Polishing
- PC Controlled with LabVIEW
- Automatic Load/Unload
- Automatic Transfer Between Chambers
- Recipe Driven, Password Protected
- Safety Interlocks
- 46”D x 44”W Footprint

Options:
- Sputter Down/Up
- Co-Sputtering
- DC, RF and Pulsed Power Supplies
- Ion Beam Assisted Deposition
- E-Beam Sources
- Plasma Sources

The NANO-MASTER NOC-4000 Dual Chamber Optical Coating System provides Ion Beam Etching/Milling and Sputter Coating capabilities for optical samples. After the samples are cleaned/polished in the first ion beam chamber, samples can be transferred to the second chamber for sputter coating without breaking vacuum.



Ion Beam Cleaning Chamber with Tilted Platen



Sputtering Chamber with Rotating, Heated and Biasable Platen

Plasma Cleaning and Ashing Systems

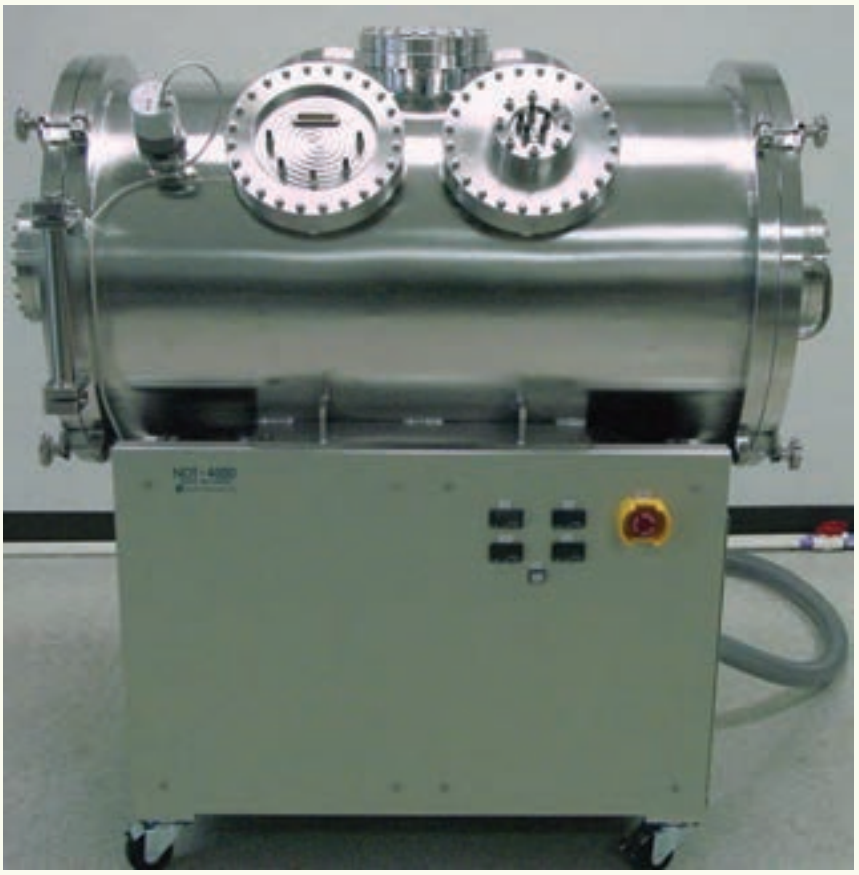
NPC-3000

Applications:

- Removal of Organic and Inorganic Materials without Residues
- Photoresist Stripping or Ashing
- Desmearing and Etch Back Applications
- Cleaning Microelectronics, Drilled Holes on Circuit Boards or Cu Lead Frames
- Adhesion Promotion, Elimination of Bonding Problems
- Surface Modification of Plastics: O_2 Treatment for Paintability
- Producing Hydrophilic or Hydrophobic Surfaces

NANO-MASTER Plasma Ashing and Cleaning Systems are designed to meet a wide range of needs from wafer resist stripping to surface modification of batch as single wafer loads. They are PC controlled systems with various plasma sources, heated and unheated substrate holders and unique ability to switch from plasma etch to RIE etch modes.

Thermal Vacuum Systems



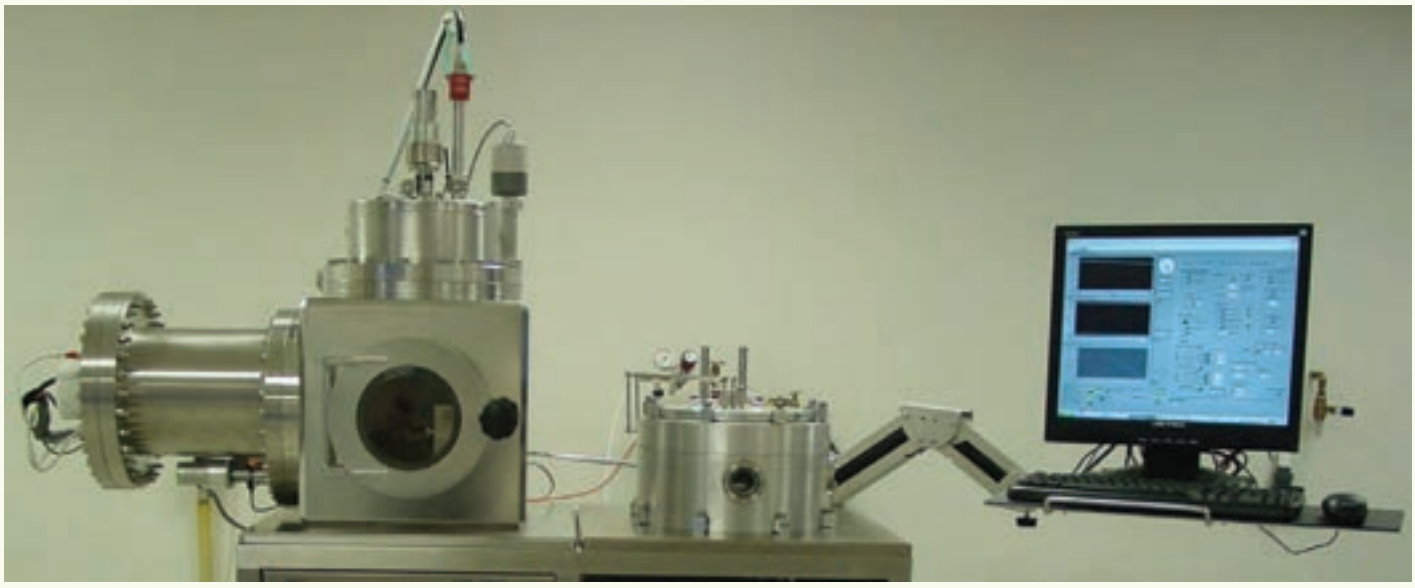
NDT-4000

Features:

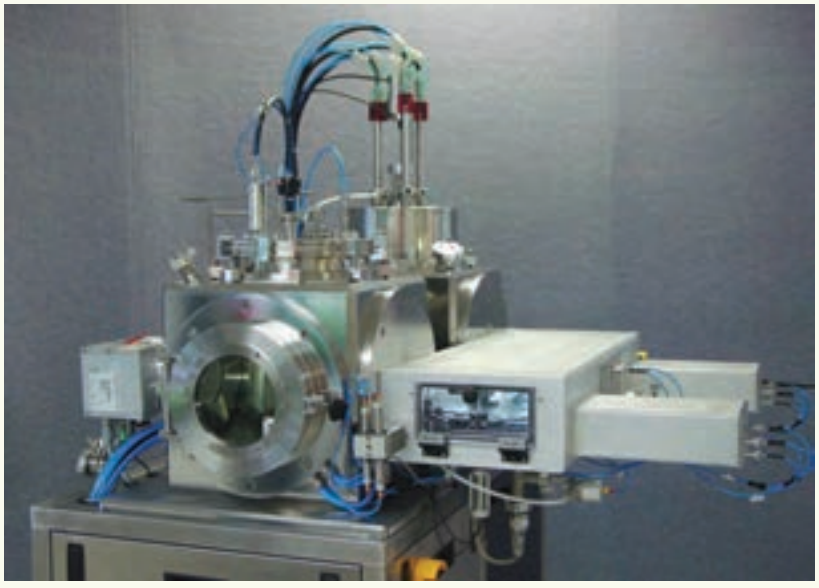
- 36 Hr Auto Run with Preprogrammed Heating and Cooling Cycles
- Computer Controlled, Safety Interlocks
- Multiple Levels of Access with Passwords
- Chamber Size: 43” in Length and 24” in Diameter
- Sliding Thermal Platform of 16” x 32”
- Thermal Platform can be Heated to 150 °C and Cooled to -100 °C
- Four Zone PID Temperature Control
- Uniformity of +/- 1 °C with 3 cm Edge Exclusion
- Thermal Platform is Mounted on Rolls, can be Pulled out to 75% of its Length for Loading/Unloading
- Chamber has Twenty 40 GHz Connectors and two 50 Pin DC Feedthroughs
- 1250 l/sec Turbomolecular and Dry Scroll Pumps
- Base Pressure $7x10^{-8}$ Torr reaches 10^{-6} Torr range in less than 20 minutes
- Three 5” Viewing Windows
- LED Chamber Lighting

Device Testing in Temperatures -100 °C to 150 °C in Extreme Vacuum for Space Simulation.

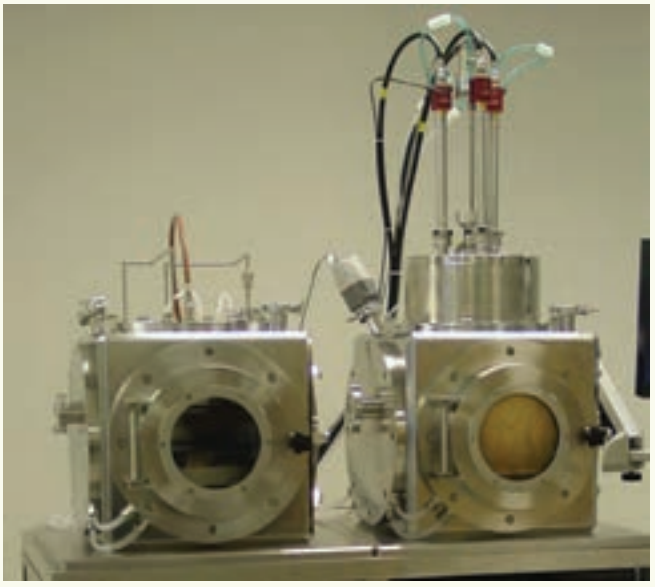
Dual Systems



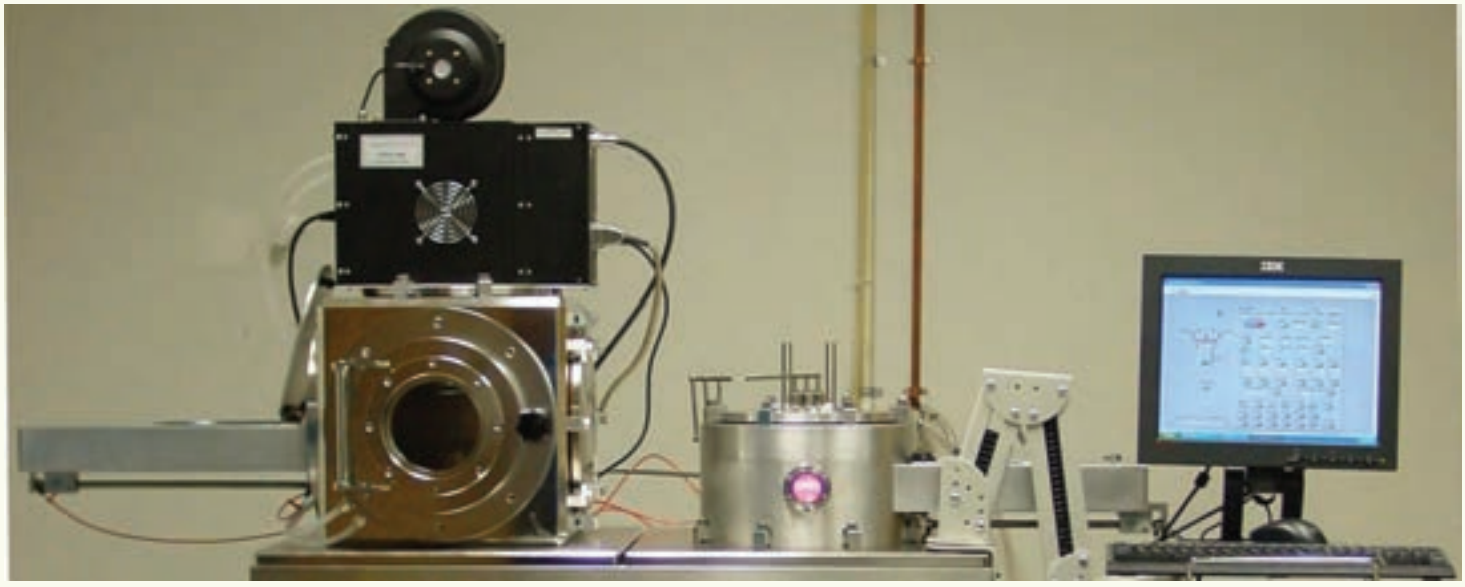
NIR-4000 Ion Beam and RIE Etching System



Reactive Ion Beam Etch / PVD System



NSP-4000 PECVD / Sputtering System



NRP-4000 ICP PECVD and RIE System with Load Locks and Auto L/UL

Single Wafer Cleaning, Resist Processing and Wet Etching

LSC-4000

LSC-4000 Chamber

NANO-MASTER state-of-the-art Cleaning and Processing Technology incorporates patented damage free megasonic cleaning, chemical cleaning, brush cleaning, high pressure and drying in one process step. To achieve maximum cleaning optimization without substrate damage, the megasonic energy density must be kept slightly below the damage threshold at any point on the sample. NANO-MASTER's patented technology assures uniform distribution of the acoustic energy across the entire surface of the substrate allowing ideal cleaning by maximizing the distributed energy while staying below the sample's damage threshold. Depending on the application, certain options will further enhance the tool's ability to remove unwanted particles and residues.

Applications:

Cleaning
- Si Wafers
- Saphire Wafers
- Chips on Wafer Frame
- Display Panels
- ITO Coated Displays
- Patterned and Un-patterned Masks
- Mask Blanks
- Pelliclized Reticles
- Contact Masks

Photoresist Processing
- Resist Coating
- Resist Lift-Off
- Resist Stripping with Piranha

Etching
- Metal Etching of Al, Au, Cr, Ti

Features:
- 21" OD, 15"x15" Substrates
- 450 mm Wafer
- Large Environmental Chamber with Megasonic DI, Brush, Hot DI, High Pressure DI, Heated N_2, Chemical Dispense Arm
- Variable Speed Brush with Chemical Dispense
- PC Controlled with LabVIEW Software
- Touchscreen User Interface
- Manual Load and Unload
- Safety Interlocks and Alarm
- 30"D x 26"W Footprint

Options:
- Chemical Delivery Module
- Piranha Cleaning
- Ozonated DI Water (20 ppm of O_3)
- Hydrogenated DI Water
- High Pressure DI Water
- Heated DI Water
- Separate Drains for Solvents and Acids
- IR Lamp Heating
- DI Water Recirculator
- Fire Resistant Cabinet

Single Wafer / Mask Cleaner

SWC-4000

SWC-3000

Applications:
- Patterned and Un-patterned Masks and Wafers
- Ge, GaAs and InP Wafer Cleaning
- Post CMP Wafer Cleaning
- Cleaning of Diced Chips on Wafer Frame
- Cleaning after Plasma Etch or Photoresist Stripping
- Pelliclized Reticle Cleaning
- Mask Blanks or Contact Mask Cleaning
- Cleaning of X-ray and EUV Masks
- Optical Lens Cleaning
- Cleaning of ITO Coated Display Panels
- Megasonic Assisted Lift-off Process

SWC-4000 Features:
- 12” OD, 7” x 7” Substrates
- Stand Alone Unit
- Damage Free Megasonic, Chemical, Brush Clean and Spin Dry
- Microprocessor Controlled
- Chemical Dispense Unit
- Separate Solvent and Acid Drains
- Heated N_2
- 30”D x 26”W Footprint

SWC-4000 Options:
- Mask or Wafer
- Ozone Cleaning
- Brush Cleaning
- High Pressure DI Cleaning
- Nitrogen Ionizer

SWC-3000 Features:
- Table Top Unit
- Damage Free Megasonic Mask or Wafer Clean and Spin Dry
- 12” circular, 7” square substrates
- Microprocessor Controlled
- IR Lamp

SWC-3000 Options:
- Mask or Wafer
- Brush Cleaning
- Chemical Cleaning (CDU)
- Nitrogen Ionizer

Pelliclized Reticle Cleaner
LSC-5000

• SC1 Clean • Megasonic Clean • Brush Clean
• IR and Nitrogen Dry • Front Side and Back Side Clean
• Robotic Handling and Transfer from SMIF Pod
• Automatic Bar Code Reader • LabVIEW Software
• PC Controlled • Password Protected Access

Single Wafer Thin Film Processing Systems

◉ **NANO-MASTER WORLDWIDE CUSTOMER BASE**

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