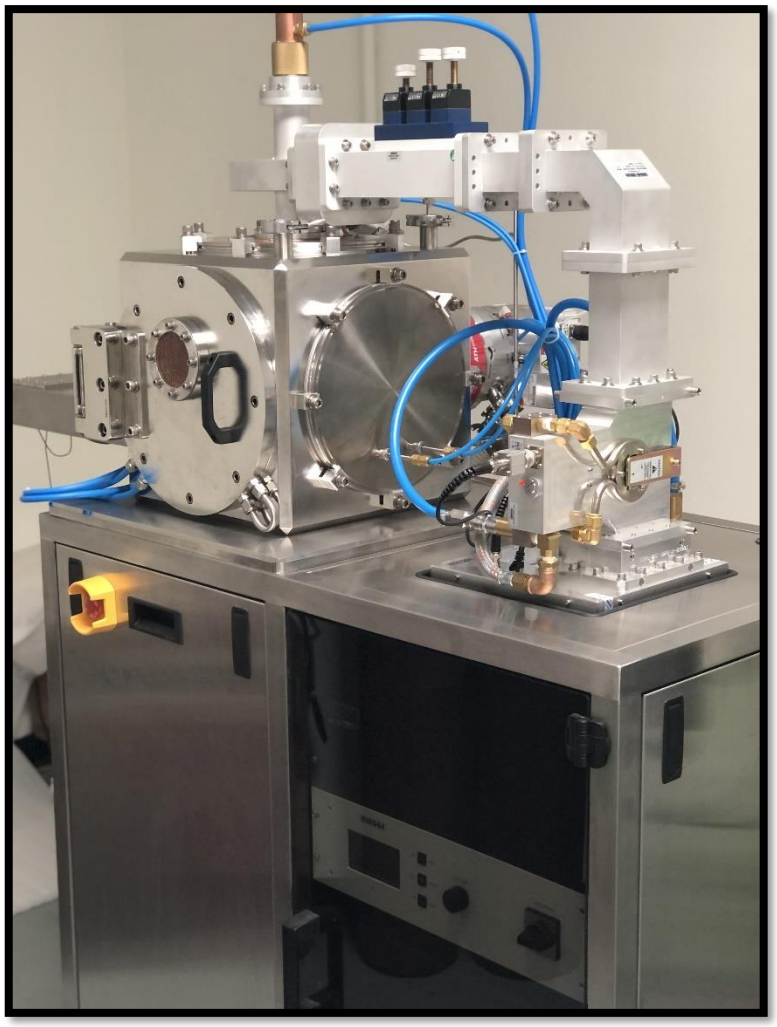
NANO-MASTER, Inc.

NMP-4000 for Depositing Single Crystalline Diamond



NMP-4000

The NANO-MASTER NMP-4000 is a stand-alone Microwave plasma-enhanced CVD system for depositing high-quality CVD single and polycrystalline diamonds for a wide range of applications and is designed to run long-duration production processes with high reliability and high repeatability. It is CE and SEMI Standards compliant, capable of processing up to 4" wafers. PC controlled with LabVIEW software featuring three levels password-controlled user authorization and touch screen monitor. The system is fully automated and safety-interlocked, recipe-driven, with status indicators, and graphic and alphanumeric displays.

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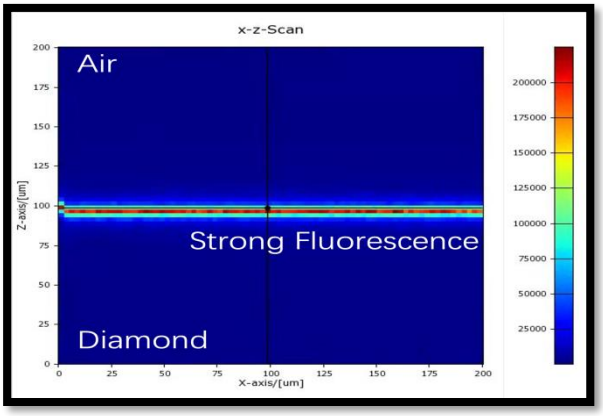
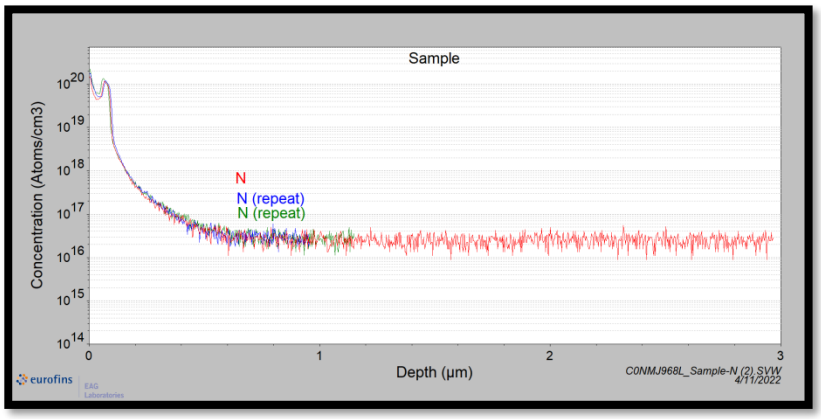
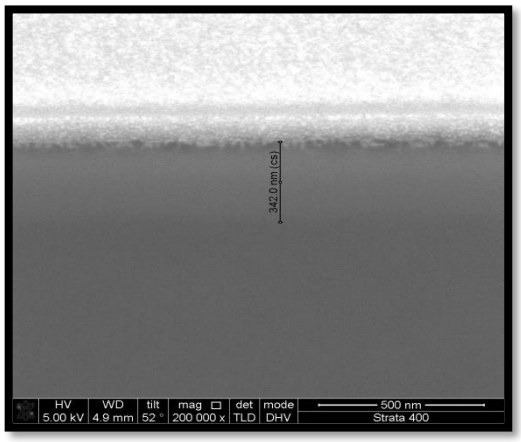


The result shows that there is a layer with strong fluorescence at the surface, which implies a successful nitrogen doping layer



SIMS results confirm the doping of two nitrogen layers on a diamond



SEM image indicated diamond deposited on the substrate with a thickness of 0.34µ with CH_4 and N_2 at 1800W power with a growth rate of 2.2nm/min

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NMP-4000 System includes:

Chamber: 14" SS cube chamber with 8" door and 5" window mounted on a SS base plate, easy access to the platen by opening the front door and easy cleaning of the chamber walls. Loading and unloading of the wafer through automatic load and unload mounted on RHS of the chamber. Chamber consists of Secondary Bell Jar chamber over the heated platen, MW screened front viewport (5") with shutter and Manual Load (8") Door w/10" Flange. Micro Wave screened front viewport (5") with shutter.

Microwave Plasma source: 2.45 GHz, 6KW Microwave source with manual tuner and coupler. Extremely stable plasma over low to high power density processes.

Auto Load and UnLoad for 4" wafer: Load Lock, pneumatic isolation door, mechanical pump and gauge. Pump to mTorr range, platen lowered wafer carrier is loaded on pneumatic 3 pins, the platen is raised and sealed against the bell jar

Platen: 4" Molybednum top, heated to a max temp of 1000°C resistively and with microwave plasma. Platen is mounted on SS bellows and movable with a stepper motor. Carrier will be provided for handling small samples.

MFC's: Six MFC's (CH_4, H_2, Ar, three N_2) mass flow controllers with SS gas lines and pneumatic shut off valves. The MFCs provide accurate flow control and monitoring for delivering for the carrier gas or reactive gas. Pneumatic high vacuum shut-off valves are placed on the outlet of the MFCs to allow the user to control gas selection during processes. User will have access to the MFCs and valves through the main system control software. All gas lines leading to the chamber are made of stainless steel with ultra-clean, orbital-welded VCR fittings

Bubbler: 150 ccbubbler for Trimethyl Borate with heated gas lines

Gauges: Wide Range Gauge - The system background pressure is measured using an Edwards WRG-D (wide range gauge) enabling it to cover a pressure range from atmosphere to 10^{-9} torr. The gauge is mounted underneath the base plate with a 90-degree elbow to minimize the deposition and to improve the gauge reliability.

Pirani – Edwards APGX active linear convection gauge. To monitor process pressure during the process, a linear convection gauge is used. It is mounted onto the baseplate and can monitor the pressure during the process with less sensitivity to process conditions than wide-range gauge.

Pyrometer: Dual-wavelength pyrometer for measuring the wafer temperature.

Pumps: Turbomolecular Pump - Pfeiffer ATH 500 MT, magnetically levitated, corrosive and heated. The turbo is mounted underneath the system baseplate through the ALD filter housing.

The ATH 500 MT has a N_2 pumping capacity of 500 l/s and is controlled through the main system control software.

Backing Pump – Ebara EV10Sdry pump. It is used as a backing pump for the turbo and has a pumping capacity of 9cfm. The dry pump is mounted at the chamber exhaust. The vacuum system configuration provides the highest conductance and lowest base pressure for given pump and chamber by mounting the turbo directly into the chamber. In a clean system, base pressure will reach mid 10^{-7} Torr and in overnight, it will be 10^{-6} Torr range in 20 minutes of pumping.

Base Pressure: mid 10^{-7} Torr in a clean system.

Process Control System: PC controlled with LabVIEW software featuring three levels password-controlled user authorization and touch screen monitor. The system is fully automated and safety-interlocked, recipe driven, status indicators, graphic and alphanumeric displays.

Facility Requirements:

Footprint – 660mm x 1118mm

Input Power – 208/400VAC, 30A/phase, 50/60Hz. Hardwire the line cord to a source capable of delivering the required power.

Chiller : Need 5KW chiller for Microwave plasma source with a flow rate of 10gpm @ 60PSI.

Compressed Air - Compressed air (CDA) is used in this system for operating pneumatic valves, chamber lift and other components. The system requires 90psi of CDA.

Nitrogen - Nitrogen tank is used for venting of chamber and for venting the turbo bearings. The system requires 10psi of Nitrogen.

Process Gases - The process gas input connections are ¼" Swagelok fittings. Process gas pressure must be no more than 20psi. For this system the gases needed are research grade purity N_2 and research grade purity O_2.

Exhaust - The output/exhaust of the backing pumps must be connected to an exhaust line for the building. The connection fittings for the backing pump exhausts are KF25 (or NW25). The building exhaust line must be able to handle the effluent produced by the process.