

NTE-3000 and NTE-4000 THERMAL EVAPORATOR SYSTEMS



NTE-3000

Nano-Master Thermal Evaporation Technology:

Evaporation is a powerful technique for thick metal or organic coatings. It is a vapor phase deposition technique and requires good vacuum. The system must be capable of going to low background pressures and have fast pump down to remove out gassing rapidly during heating of the sample.

High temperatures must be reached to melt the material under vacuum to coat the substrate. Typically any material where evaporation temperature is less than 2000 °C at about 10^{-5} Torr can be evaporated; however, appropriate crucibles (Alumina, Quartz, Boron Nitride etc) must be chosen. Organic materials require lower temperatures about 600°C with better control. However, some materials have low sticking coefficient making it difficult to build a film. The substrate is typically not heated but for some applications substrate heating may be necessary to control the stoichiometry.

Another process for coating films is sputtering. In contrast to evaporation, the sputtering is more appropriate where substrate temperatures have to be low or thinner films with varying composition or dielectric films are needed. Sputtering requires higher pressures and Argon atmosphere; but generally speaking, both evaporation and sputtering processes require systems with many common features.

The NTE-3000 Table Top Evaporation System and NTE-4000 Stand Alone Evaporation System share a common platform with our sputtering systems; cabinets, chambers, vacuum pumping package, and computer control architecture are same in both evaporation and sputtering systems except one uses magnetrons and the other heated crucibles. As a result, many technologies that we have developed for our sputtering systems are also available for our Thermal Evaporators: Platens with heating, rotation, and bias; plasma cleaning prior to coating, thickness monitoring, and sequentially or simultaneously operating multiple sources; Bell jar, Aluminum or Stainless Steel chambers; load-lock and automatic load unload mechanisms.

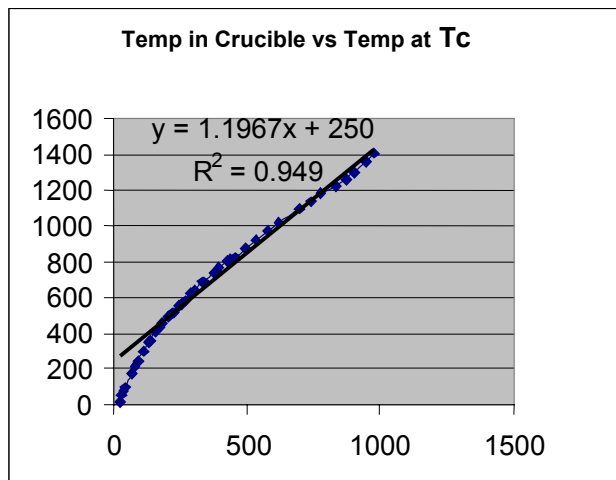
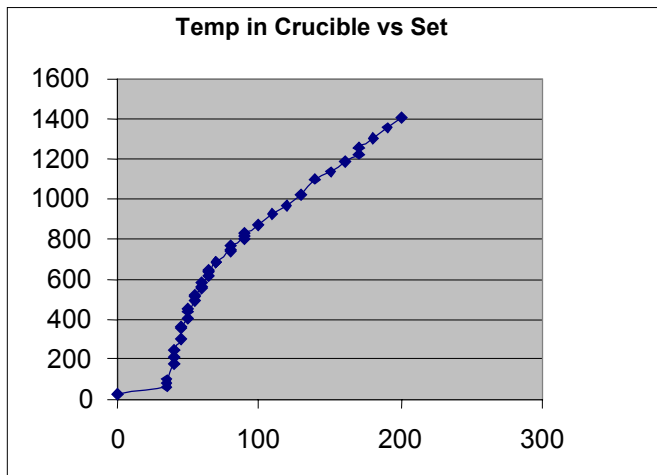
NTE-3000 looks very similar to Nano-Master NSC-3000, except the platen is on top and samples are held face down. Because of many commonalties we are also able to offer dual sputtering and evaporation capabilities on NTS series systems (NTS-3000, NTS-4000). Having a computer controlled system, we can provide both sputtering and evaporation capabilities in the same system and in the same footprint, making possible to take advantage of both sputtering and evaporation techniques without breaking vacuum.

Another unique feature of Nano-Master, evaporation system is to control the duration of the heater current rather than the amplitude. The system is equipped with a solid state current control circuitry as opposed to a variac as in many other systems. In this system, the duration of the current or the RMS value is controlled. User can select a set point, which in effect sets the portion of the half period the AC voltage will appear across Tungsten heater wires. As a result, a very precise and a fast control of current is achieved, and therefore a closed loop temperature control is possible. Furthermore, the current control and therefore the temperature control, meet stringent requirement of the organic evaporation whether it is used for organics or metals.

We have measured the RMS voltage, the RMS current, the temperature in the crucible T_B , and the temperature at the thermocouple T_C in contact with the bottom of the crucible. The experimental heating results with empty crucibles are shown below. These experiments are carried at 208V line voltage. Current and voltage (not shown) measured with true RMS meter.



NTE-3000 and NTE-4000 THERMAL EVAPORATOR SYSTEMS



Using the above temperature and current relationships we can set the current to achieve the desired temperature in the crucible and control it with the temperature measured by the thermocouple. By putting material in the crucible thermal losses and heating time constants will vary, however the relationship between the temperature in the crucible and the thermocouple measurement will not change. Therefore we have a technique for establishing the temperature in the crucible independent of the mass of the material loaded or even the value of the line voltage.

Description:

Nano-Master NTE-3000 is a PC controlled table top thermal evaporator system with wide ranges of applications in organic to metal evaporation. It is designed with extreme care to achieve clean, uniform, controllable, and reproducible process on a small footprint. It provides a low cost, high quality, advanced capability to end users with demanding applications in R&D and low volume manufacturing.

It is a dual source system that can accept standard crucibles for sequential evaporation of organics or metals. Each crucible is monitored with an R type thermocouple. These thermocouples are characterized with a thermocouple placed in a crucible, and therefore their readings can be directly translated in to the inside temperature of the crucible. Both sources are enclosed in a radiation shield and a rotating shutter provided to prevent cross contamination during operation. The electro polished Stainless Steel dual source assembly is mounted on a Ni plated Aluminum base plate and it is water cooled.

The standard system comes with 0.5" diameter 0.5" high Alumina crucibles; however, it is capable of accepting crimped boats or other configurations of crucibles.

The platen can accept up to 6"x 6" plates and 200 mm wafers. It is mounted on the top of the chamber, and the substrate is held on four edges in face down configuration. Substrate holders are adjustable for size and for arbitrary shape work pieces. Platen assembly rotates at 1-3 RPM with a DC motor coupled through a differentially pumped seal. The platen can be removed easily for cleaning. The crystal thickness monitor is mounted at the edge of rotating platen and it can be calibrated to have fully automatic sequential evaporation of two materials without breaking vacuum. Both the platen and the crystal thickness monitor is easily accessible by lifting the top cover.

The vacuum chamber consists of a 12" diameter 12" high Pyrex bell jar, Ni plated Aluminum base plate, and an Ni plated Aluminum top cover that opens for sample load and unload. To achieve a good film composition it is important to have low background pressure. For faster pump down, 70 L/sec turbo molecular pump with a 3.5 cfm mechanical pump is used. Pressure is measured with a wide range gauge. System pumps down to 10^{-6} Torr range in 20 minutes after it is exposed to atmosphere for a short period of time. Base pressure is about 3×10^{-6} Torr and achieved in 8 hours. All the motion seals are differentially pumped and temperature sensitive components such as crystal mount, turbo, source and the base plate are water cooled.

NTE-3000 and NTE-4000 THERMAL EVAPORATOR SYSTEMS

The power supply has 2KVA capacity and the step down transformer has 1:10 ratio delivering 20V output and the peak current is in excess of 240 Amps. The voltage waveform is gated for a short duration of each AC cycle to control the value of the RMS current or RMS voltage, which in turn sets the power delivered or temperature reached.

The NTE-3000 system is a PC controlled system with three levels of authorizations: Operator, Engineer and Service. It is fully interlocked for safety, water cooling, transition from mechanical pumping to turbo molecular pumping, venting, power interruption, maximum current settings for metal and organic evaporators, etc. Recipes can be set in the Engineering mode and the operator can run the existing recipes. The RMS current voltage and power, pressure, thickness, the temperatures of both the material in the crucible and the thermocouple are displayed. User can set a temperature and thickness then the system would pump down, turn on the heaters at the right pressure, automatically cover the unused source with the shutter, and terminate the process when the desired thickness is reached and vent it slowly with Nitrogen.

The manual version of the system is called NTE-2000 and both systems have the same cabinet footprint of 26"x26" x 30". Extreme caution must be exercised by the user to exhaust the gaseous by products safely. At the end of process system is flushed with Nitrogen but for applications having toxic gaseous by products appropriate hood or in a glove is recommended.

Features:

- 70 or optional 200 l/sec turbomolecular pump backed with a mechanical or a dry pump
- Bell Jar chamber
- 2KVA SCR controlled
- Water cooled dual crucible source
- Rotating platen 1-3 RPM
- RF, DC bias or heating (optional)
- RF plasma cleaning (optional)
- Thickness monitor
- Compact, PC controlled
- Small footprint
- Temperature control
- Max Temp 2000°C for metals, 800°C for organics



Dual Crucible Source

Models:

NTE-2000	PLC controlled table top dual source Thermal Evaporator
NTE-3000	PC controlled table top dual source Thermal Evaporator
NTE-4000	PC controlled, stand alone dual source Thermal Evaporator
NTS-3000	PC Controlled, table top Sputtering and Thermal Evaporator System
NTS-4000	PC Controlled, stand alone Sputtering and Thermal Evaporator System

Options:

- Co-evaporation
- Sputtering (RF or DC, max. two 2" magnetrons)
- Heated Platen
- Biasable Platen
- Plasma Cleaning of the Substrate
- Aluminum chamber
- Shutter for Crystal Monitor
- Shutter for Magnetron (Sputtering option)
- 200 L/sec Turbo
- Load lock (metal chamber)

NTE-3000 and NTE-4000 THERMAL EVAPORATOR SYSTEMS

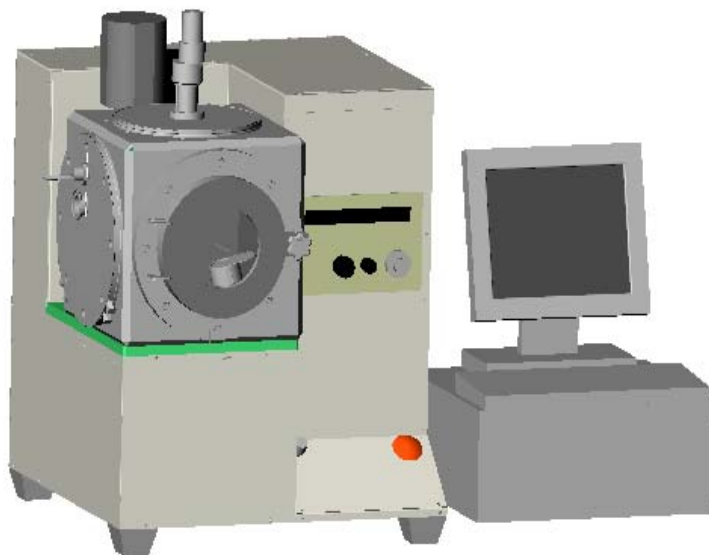
Specifications:

NTE 3000

Control	PC, Automatic, recipe driven, three levels of password protected authorization
Chamber	12"D, 12"H Bell Jar
Max Substrate Size	8", 6"x 6"
Substrate Rotation	1-3RPM DC motor
Thickness Monitor	Maxtek 350 Thickness Monitor with Crystal holder, 100 recipes
Source	Dual ½" D, ½"H crucible with heat shield and auto shutter
Temperature	1800°C (max 2000°C) for metals and 600°C for organics, measured with R type Tc and closed loop controlled
Power Supply	2KVA
Rated Current	100 Amps RMS for metals, 50 Amps RMS for organics
Max Current	140 Amps RMS for metals, 80 Amps RMS for organics
Max Peak Current	250 Amps
Max Peak Voltage	20V
Pressure	3x10 ⁻⁶ Torr with 70 L/sec Turbo and 3.5 CFM mech pump
Pump Down Time	Atmosphere to 10 ⁻⁶ range in 20 minutes

Facilities Required:

Foot Print	26" W x 26" D x 30" H
Weight	200 lb.
Power Requirement	208V or 220V, 20 Amps
Water Cooling	15 C, 2G/min
Gasses	N2 for venting



NTE-3000 with Aluminum Chamber