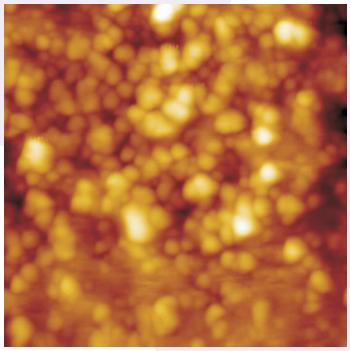
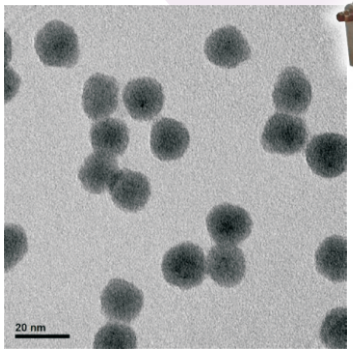
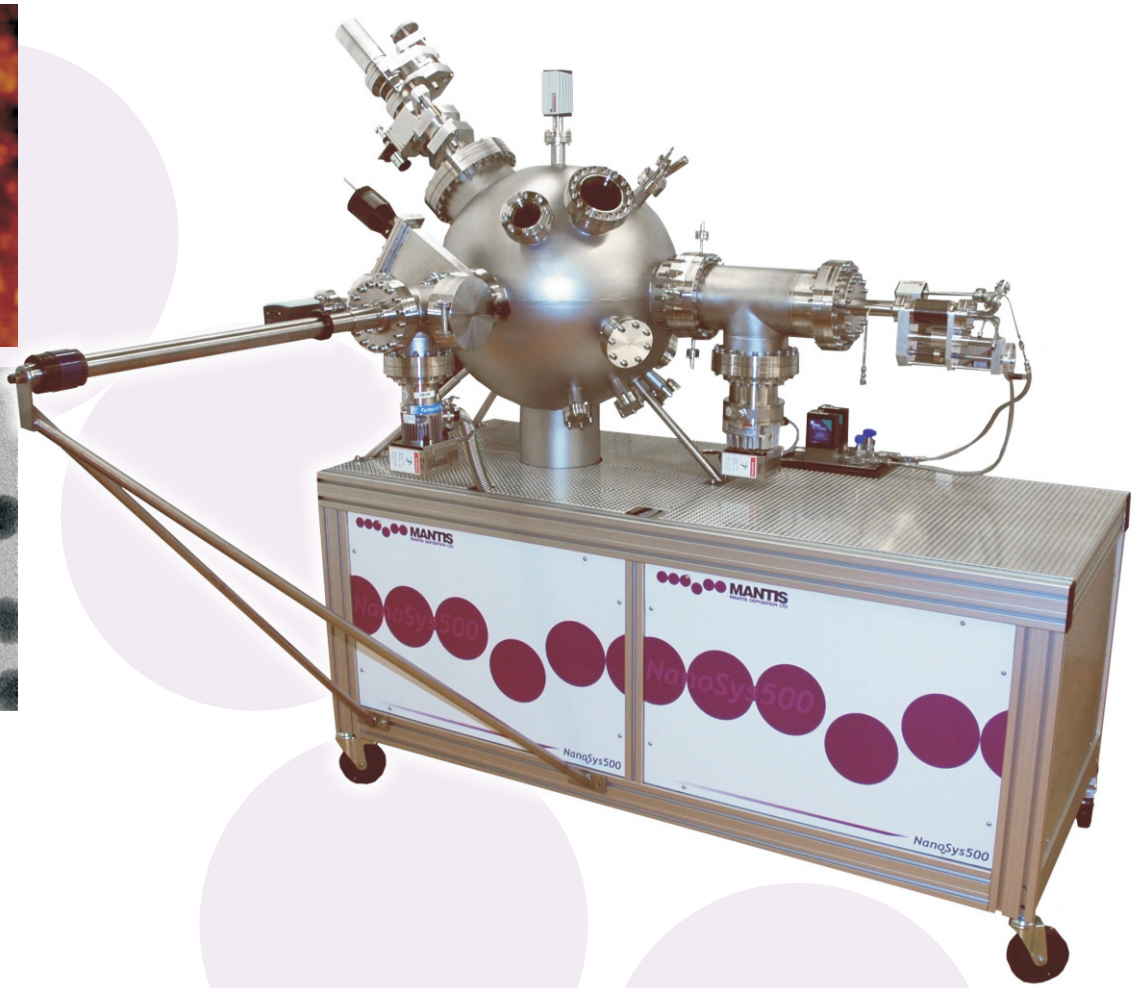
Nanosys500

Nanoparticle deposition systems







Features

- Flexible R&D nanoparticle deposition system
- True UHV
- Compound and core-shell nanoparticle generation
- Variable energy deposition
- Nanoparticle size variation +/- 5% (flow/power dependent)
- Deposition rate 6 A/s
- Variable coating structure from powdered films to single crystal
- Coating of delicate plastics and organics

Applications

- Thin-film solar cells
- High-efficiency photovoltaics
- Gas sensors
- Catalysts
- Semiconductors
- Bio coatings
- Medical devices

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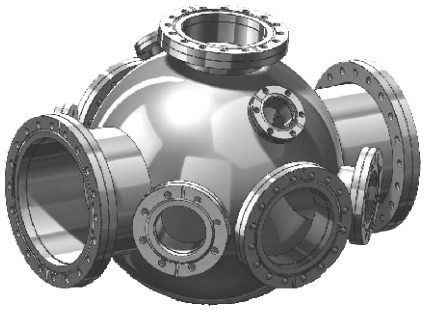
Base chamber

Chamber configuration



The Nanosys500 system offers true UHV integrity combined with features crucial to allow the user to explore full potential of nanoparticle deposition.

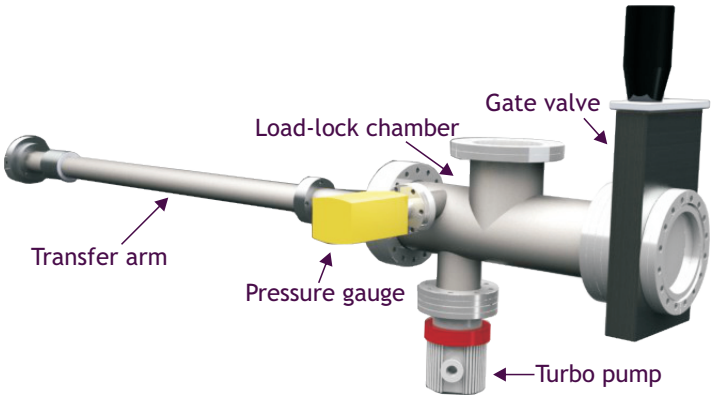
The main chamber is of a spherical construction with all ports axes passing through the centre-point. The chamber has internal welds and is polished to minimise outgassing. Numerous ports are provided for deposition components, with emphasis on below-horizontal alignment to accommodate instruments which use crucibles to contain evaporant, such as effusion cells. The chamber can optionally be equipped with removable cross-contamination shielding in applications where high rates of deposition are required.

System evacuation

The system uses turbodrag pumps with dry backing pumps as standard, enabling pressures in the low 10^{-9} or 10^{-10} torr to be achieved (after bakeout). Alternative pumping system can be incorporated at customer request.
The system is configured as standard with full-range gauges to allow seamless pumpdown monitoring.

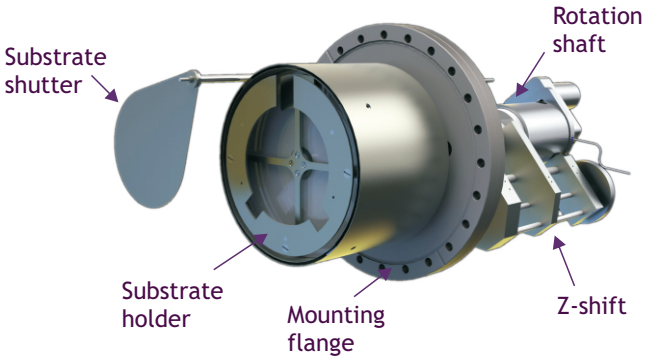
Sample loading

In the basic system, sample entry can be made through a quick-load hinged door (o-ring sealed). For true UHV applications it is necessary to use a sample entry load-lock. Our load-lock uses a magnetically coupled linear/rotary transfer arm to transport samples to the main chamber. Optionally, a sample holder carousel can be included to allow multiple samples to be loaded in the load-lock chamber.



Sample manipulator

The Nanosys500 uses a proven sample manipulator with 2" sample capacity, 50rpm rotation speed, heating up to 800 degrees centigrade and linear movement in the port axis as standard. Additionally, sample bias and unique custom mounting arrangements can be incorporated at customer request.



Film monitoring

The system can be equipped with a retractable UHV quartz-crystal monitor to allow accurate determination of the film growth rate at the sample position.
Optionally additional analysis equipment can be included at the user's request.

Automation

The system can be automated using touchscreen-based pumpdown and process automation.

Deposition sources

Mantis can offer various deposition sources for sample preparation or growth from its selection of in-house deposition instruments or can incorporate sources at the user's request.

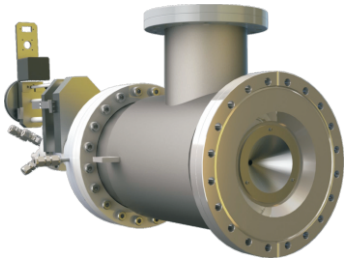
E-beam evaporators - for thin film deposition of refractory metals or high-temperature ceramics. These instruments feature integral flux monitoring for all pockets, independent high-voltage lines, efficient structural cooling, evaporation from rods or crucibles and co-deposition of up to four materials.

RF ion sources - for etching or assisted deposition. The sources provide a broad, uniform beam in the range 0-1keV with high current density. They have dual or triple grid system and are compatible with O_2, N_2, H_2, Ar.

Atomic sources - for generating atomic oxygen or nitrogen for in-situ growth of oxide/nitride films or reaction with the emergent nanoclusters. They can be fitted with unique beam thermaliser to produce low energy atoms. The sources are compatible with 0_2, N_2, H_2, CH_4.

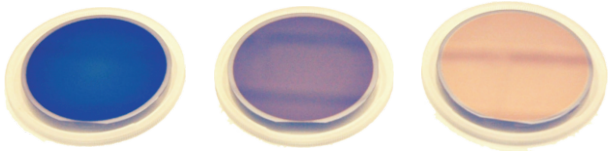
Components

Nanoparticle generation



Nanosys500 is usually fitted with a nanoparticle source NanoGen50. The nanoparticles (NPS) are produced by a 'terminated gas condensation' method. As a result they tend to posses one additional electronic charge and this allows them to be electrostatically manipulated either through deflection, focusing or acceleration. The acceleration towards the substrate allows the particle impact energy to be controlled precisely. At low acceleration (<<1eV per atom) the particles soft-land without deformation. At higher energies they undergo a small degree of interface mixing and form a layer of bound nanoparticles. At very high energy the particles fuse to revert to bulk material. Such nanoparticle manipulation produces a wide variety of coating morphologies from nanoparticle powder, through porous films to crystalline structures.

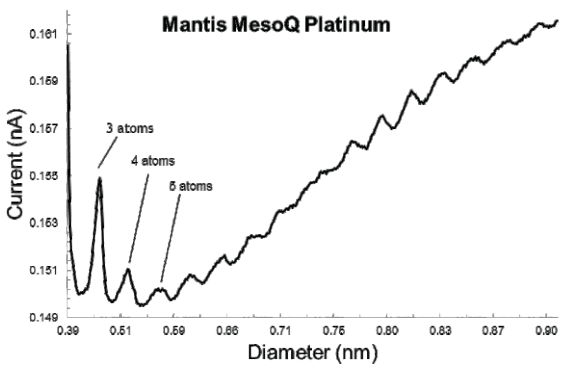
Effect of bias (5 nm Cu on GaAs)



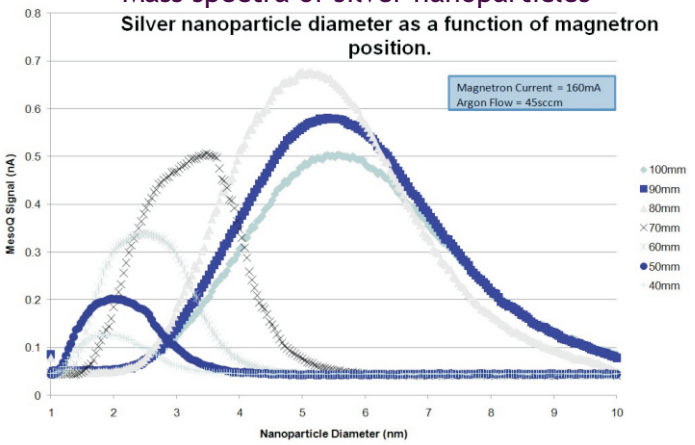
300 V 1000 V 4000 V

The gas flow characteristics within NanoGen50 ensures refinement of size distribution of the beam to allow precise definition of the particle size in the emergent beam. The source can be supplied with user-selectable refinement zones to suit particular applications. Nanoparticles can be generated with as few as 30 atoms up to those with diameters close to 20 nm.

The MesoQ quadrupole mass filter can be used in line with the NanoGen50 to analyse and further filter the nanoparticle beam with throughput up to 10^6 amu. The quadrupole has an ultimate size resolution of 2% filtering mode, allowing precise particle size definition to be achieved. It is supplied as standard with software control for analysis from a windows-based PC.

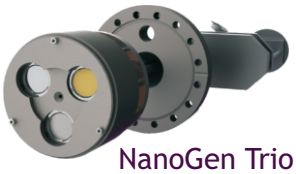


Mass spectra of silver nanoparticles



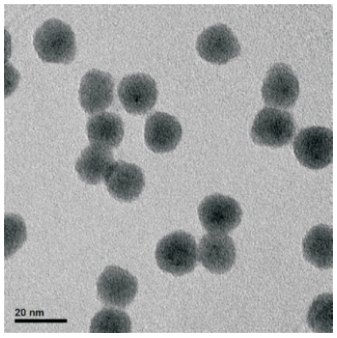
Deposition of compound nanoparticles

Compound nanoparticles such as oxides, hydrides and nitrides can be grown by adding a small amount of the reactive gas to the aggregation zone of NanoGen50. It is possible to control the mole fraction and (thus physical properties of material) of additional element by control of the partial pressure.

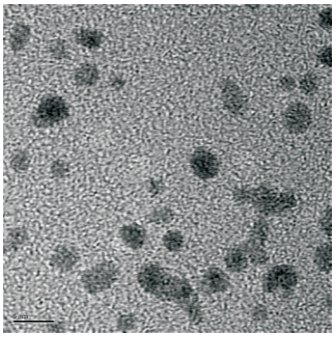


NanoGen Trio

NanoGen Trio has three independent coplanar targets, which allow deposition of complex alloy nanoparticles. It is achieved by a precise gas flow control to create rapid mixing of atomic vapour sputtered from different targets.



TEM image of TiO_2

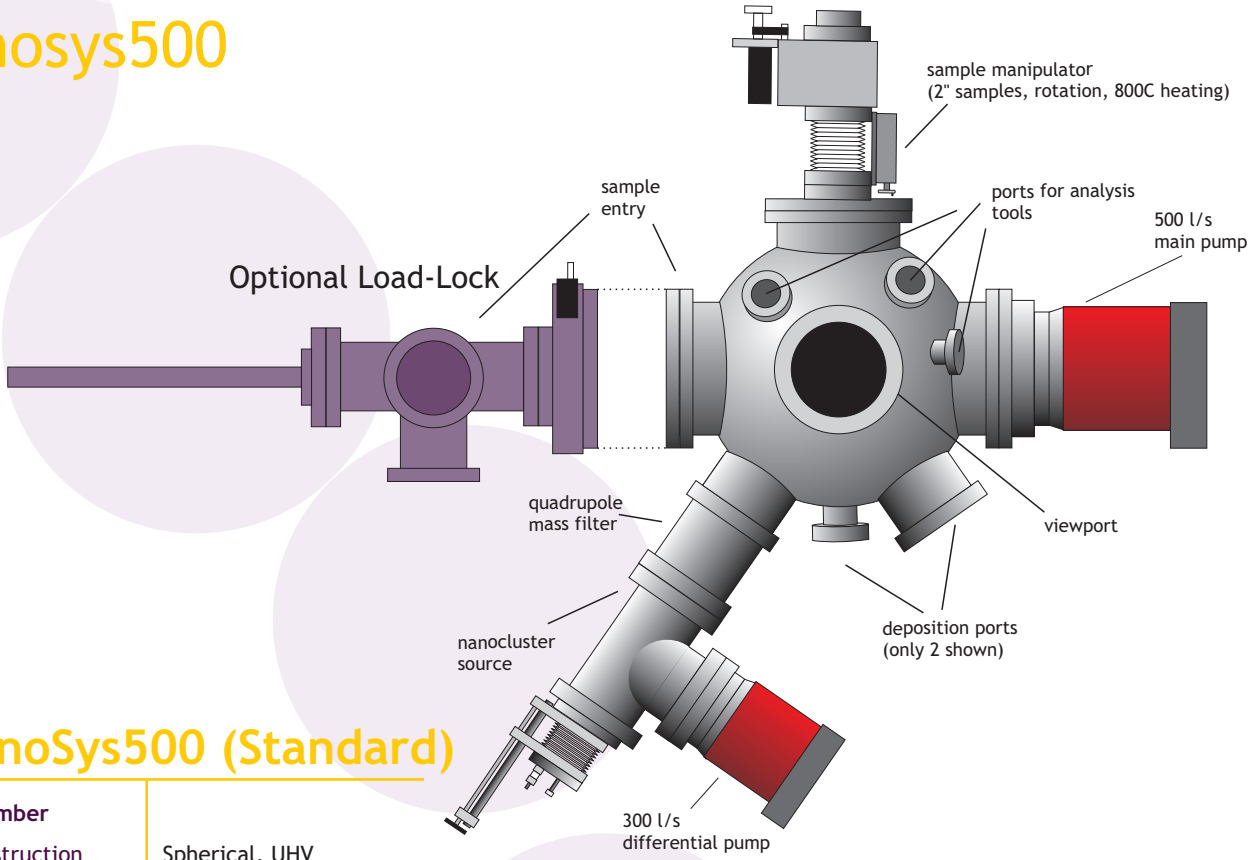


TEM image of Pt/Ru

To further extend NanoGen50 functionality, it could be connected in line with a core-shell coater Nanoshell. The nanoparticle beam coming out of the nanoparticle source enters the Nanoshell chamber, where it travels through the vapour generated by a linear magnetron source and becomes coated with the sputtered material. To ensure more efficient coating, the beam is collimated and decelerated by a series of electrostatic lenses. The resulting coreshell coated nanoparticles could be deposited on a substrate.

Specification

Nanosys500



NanoSys500 (Standard)

Chamber	
Construction	Spherical, UHV
Port focus	Centre of sphere
Ports	3 x NW200CF 1 x NW150CF 2 x NW100CF 4 x NW63CF 7 x NW35CF
Pumping	
Main pump	500 ls^{-1} Turbodrag
Differential pump(NanoGen50)	300 ls^{-1} Turbodrag
Backing pumps	Dry pumps (scroll)
Manipulator	
Sample mount	Suitable for 2” samples
Other	
Electronics	19" cabinet-mounted
Gauging	Ion gauge/Pirani
Frame	Low footprint frame on transport casters

Options

Bakeout	Internal
Load-lock	
Pumping	70 ls^{-1} Turbo
Mounting	NW100CF
Transfer	Magnetically-coupled transfer arm
Manipulator	
Rotation	Up to 50 rpm
Heating	To 800 °C
Z-Travel	25 mm
Bias	
Film Monitoring	
QCM	UHV-compatible, quartz-crystal monitor
Automation	Please contact Mantis for full automation specification

Utilities

Gases: Argon, Helium, Oxygen (optional), Nitrogen (optional)
Cooling: Water (de-ionised *not* necessary), 0.5 l/min
Power: Dependent on configuration.

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