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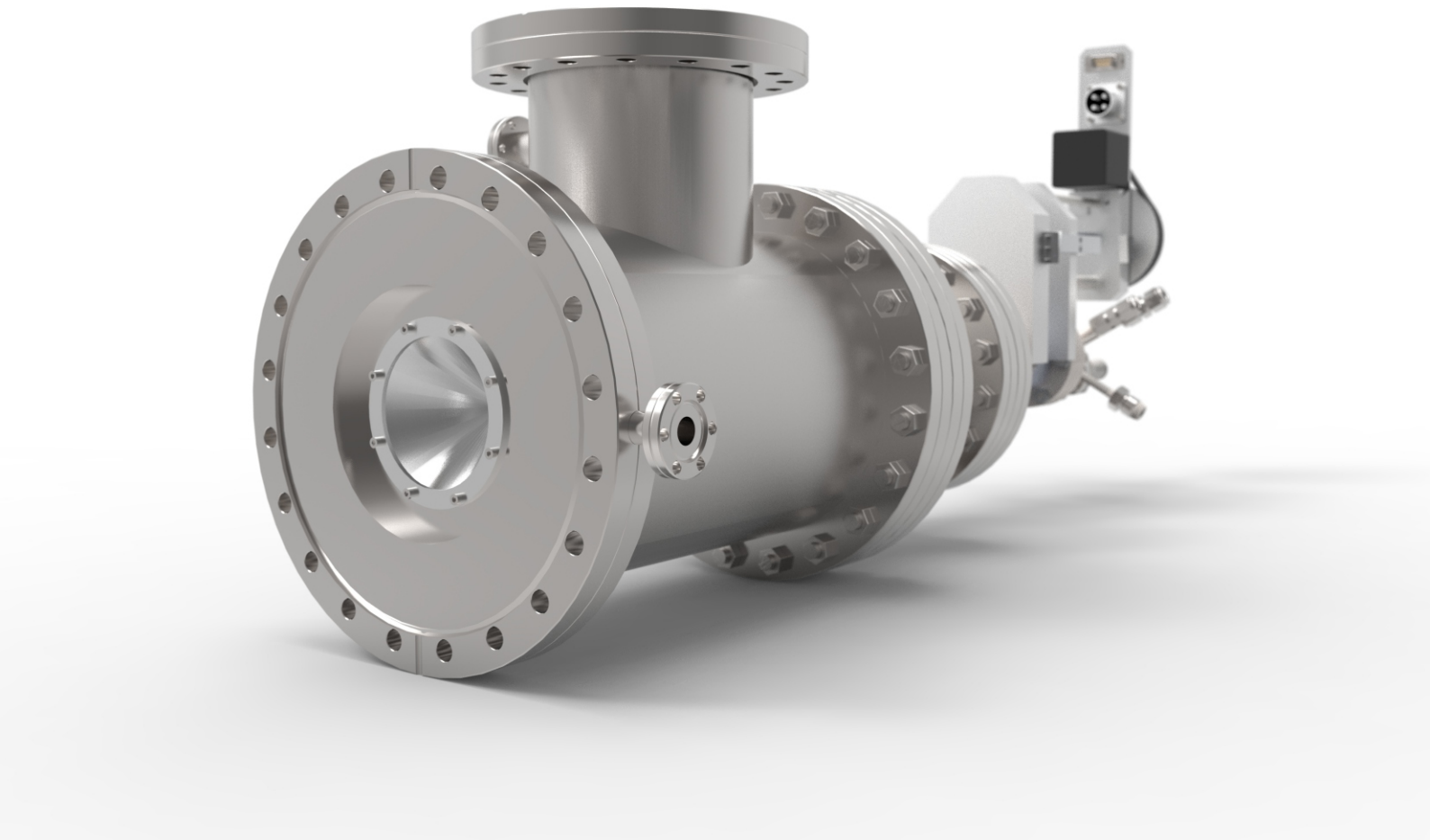
NANOTECHNOLOGY

NanoStream

UHV Nanoparticle Sources for Ultra-Pure Films



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The Technology

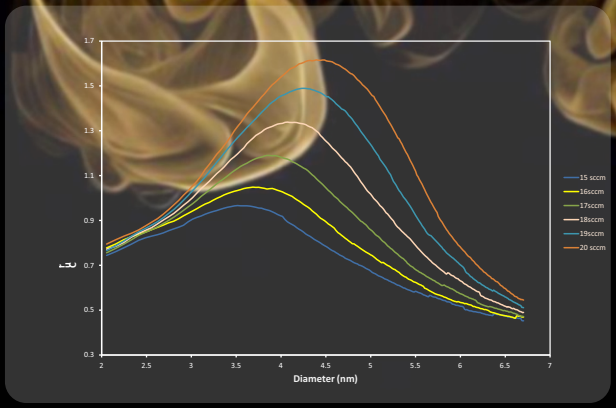
Terminated Gas Condensation

Ultra-pure size-selected nanoparticles

Terminated Gas Condensation (TGC) describes the process in which a vapour condenses into particles at high pressure for a specific length of time such that the size of the particles can be well defined. In the Nanostream sources, Nanoparticles (NPS) are produced by the TGC method using mostly DC sputtering to generate the vaour, although other techniques can also be employed. The sputtered atoms enter the high pressure condensation zone where their mean free path becomes very small and they quickly thermalise. Nanoparticles are formed as these thermalised atoms migrate towards the expansion zone.

An advantage of using sputtering is that the NPS generated by this method 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 (<< 1 eV 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.

Mean diameter variation as a function of gas flow



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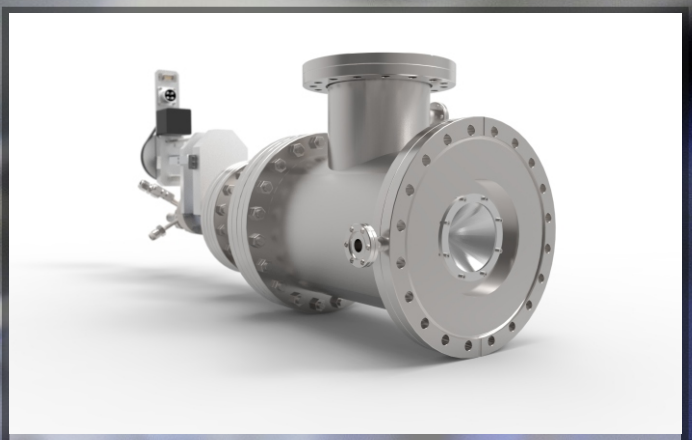
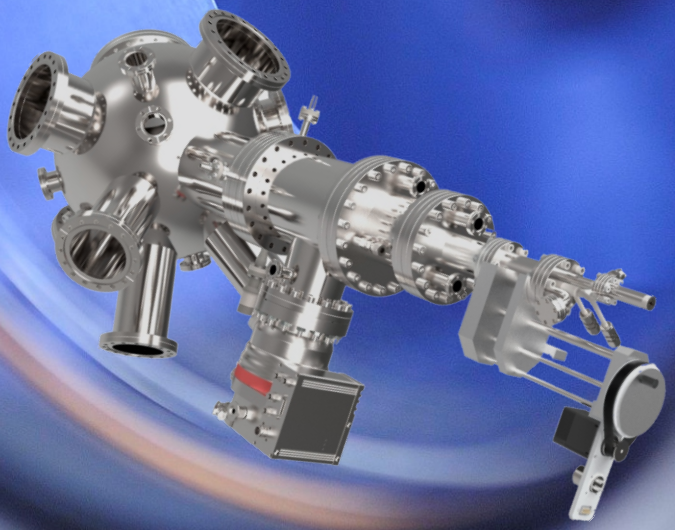
The Product Range



NanoStreamS

The NanoStreamS uses a modified DC sputtering source to generate the vapour in the condensation zone. The source accepts conventional 2"/50mm targets. Argon is used as the main sputtering gas to ignite the plasma at the surface of the target but Helium can also be added as a carrier gas which affects both the charging ratio and the flow characteristics of the particle/gas mix through the condensation zone. Finally, a small fraction of reactive gas (O2 or N2) can be added to encourage compound formation in-flight. The condensation zone can be cooled with water, LN2 or sub-zero water/glycol mix. The temperature in the condensation zone affects the thermalisation process and consequently the particle size and flux.

The gas flow characteristics within the condensation zone ensure the refinement of the size distribution of the beam to allow precise definition of the particle size. The unique configuration of the condensation zone also maximises the ratio of nanoparticles to carrier gas entering the main deposition chamber. 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.



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The Product Range

NanoStreamT

The NanoStreamT source is a variant with three 1" sputter targets, each with independent power control. This enables the creation of alloy nanoparticles with specific material composition. In some cases the particles will naturally form Janus particles; effectively two unalloyed particles bound together or core-shell particles, in which the two materials naturally condense out as a core of one material and a shell of a second. Using power and temperature variation gives users a degree of control over the preferred state of the particles.

Mass Filter

The MSF quadrupole mass filter can be used in line with the NanoStream sources to analyse and further filter the nanoparticle beam. The mass range extends from 2 amu up to 10^6 amu with an ultimate size resolution of 2% in 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. The MSF can also optionally be equipped with beam focussing and steering electrodes to target either specific areas of a substrate or to scan the beam for large-area coatings.

Accessories: Full source automation, Glovebox Integration, Core-shell accessory, Beam Focus\Steering

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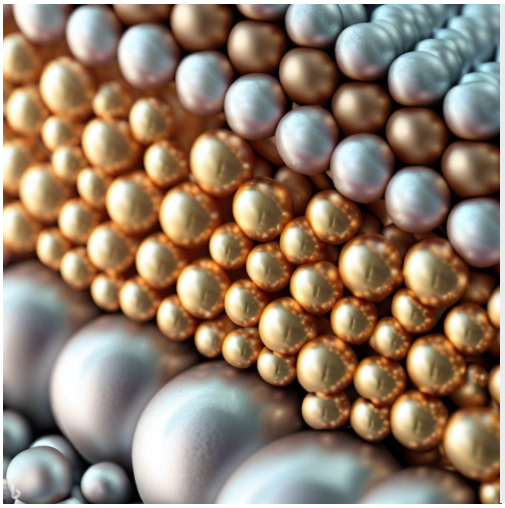
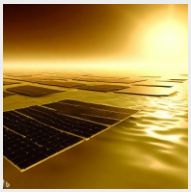
Applications



The combination of features of the NanoStream sources allows multilayers to be deposited with each layer having widely different properties.

- Alternating layers of large and small particles
- Multiple materials in one film
- Compacted films formed by accelerating the nanoparticles into the surface
- Highly porous films with orders of magnitude greater surface area than conventional films
- Nanoparticles embedded in a matrix or solid material

Photovoltaics
Size-selected embedded particles



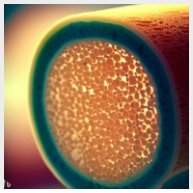
Energy Storage
Nanostructured electrodes

Gas/Liquid Sensors
Highly Specific
Ultra Pure

Catalytic materials
Huge surface area vs solid films

Medical Devices
Nanoporous membranes

Nanoporous films
Tailored porosity
Compacted nanofilms



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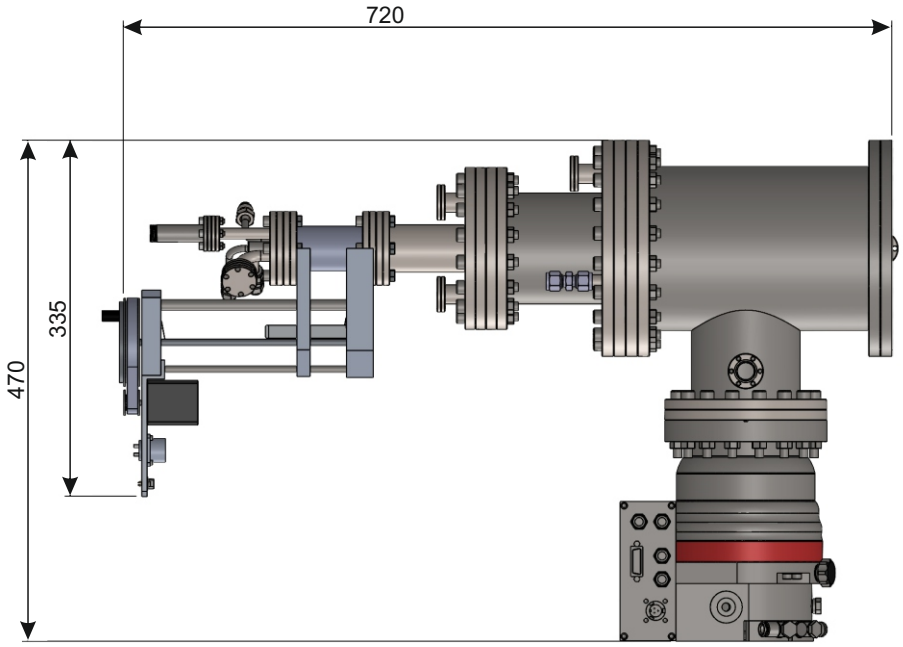
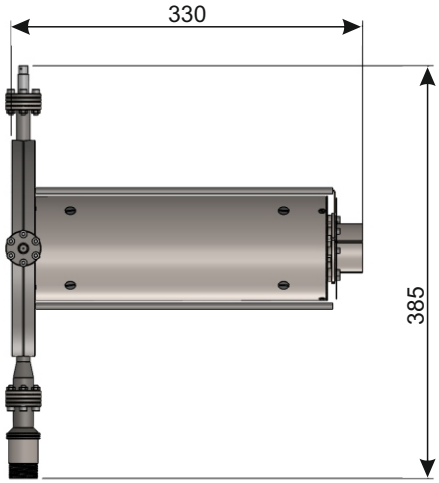
Specifications

NanoStreamS/NanoStreamT



MSF Mass Filter



NanoStreamS/NanoStreamT	
Mounting Flange	NW150CF
In-vacuum Length	0 mm
NP Size Range	1-30nm typical
NP Size Variation	+/- 10% typical
Cooling	Water/LN2
Gas	Ar. He, N2, 02 optional
Power	110/220V, Max 4kW

MSF Mass Filter	
Mounting Flange	NW150CF
In-vacuum Length	330mm (Optional 0mm)
Measurement range	2-10^6 amu
Resolution	+/- 2%
Power	100/220V, Max 1kW
Control	PC Software Windows 10 or later

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