Vacuum Systems

15

In This Section

page(s)

Kurt J. Lesker Company

➤ System Components Reference

KJLC®'s two manufacturing facilities (U.S. and U.K.) specialize in making computer-controlled, thin film deposition systems. Each system is based on a standard platform, but each is customized to suit the customer's exact application. Here, our standard CMS-18™ platform is shown with callout's to typical vacuum system components and some of the many deposition process modules available.

13. Sample rotation, heating, and glow discharge

Callout	Part
1	Process Pressure Measurement and Control
2	Dry Rough Pump
3	Process Automation & Control Power Supplies & Controllers Deposition Controllers
4	Emergency Shut-Off Button
5	Substrate Linear Transporter
6	Chamber Top Plate Hoist
7	Load Lock High Vacuum Pump
8	Viewport and Shutter
9	Pressure Measurement
10	High Vacuum Pump
11	Utilities Distribution and Control
12	Substrate Heating, Rotation, and Bias
13	Load Lock
14	Deposition Chamber

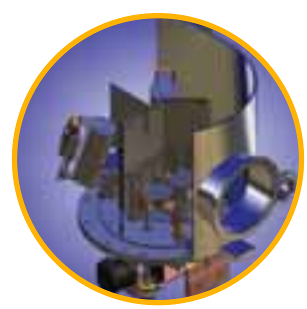
14. Low-volume load lock

15 Deposition Techniques

a. Multiple TORUS® sputter sources with ion cleaning source

b. Electron beam evaporation source for multiple-layer deposition

c. Thermal evaporation sources



d. Metals evaporation and low temperature effusion sources for organic materials

➤ System Components Reference

Thin-Film Deposition

The range of products and processes that need a vacuum system is too extensive to describe. This section, therefore, will briefly describe the most important vacuum process (technically and commercially)—**thin film deposition**.

Film deposition by thermal evaporation was first reported in 1887. In the past 50 years, the number of vacuum deposition techniques has multiplied and the thin film uses have grown exponentially. Many modern products for consumer, commerce, military, medical, or research applications depend on thin films (**see side bar**.)

Thin-Film Deposition Methods

The methods used to deposit thin films are split into:

- **Physical Vapor Deposition (PVD)**
- **Chemical Vapor Deposition (CVD)**

depending on the underlying principles causing the deposition. A PVD method evaporates or sputters a material, producing a gaseous *plume* or *beam* that deposits a film on the substrate. (The Deposition Tables in **Section 17** suggest which PVD techniques apply to what material). A CVD method uses reactive, volatile compounds that decompose onto a heated substrate. The starting materials are often organo- or hydrido-compounds that pyrolyse at relatively low temperatures into a non-volatile (film) component and a pumpable vapor/gas.

Both methods sub-divide into a variety of techniques with auxiliary mechanisms to achieve some goal.

Physical Vapor Deposition

The major PVD techniques are Sputtering, E-Beam Evaporation, and Thermal Evaporation.

Sputtering

The principles of sputtering are described in **Section 11**, Tech Notes. In all the variations of sputtering, the bulk material (from which thin films are made) is called the *target* or *cathode*—the latter indicating its electrical potential during sputtering.

Diode/Magnetron Sputtering

Early *diode* sputter sources used contoured targets to shape the electrical field to optimize the plasma. But the diode's inefficiency and complex target have meant it has been mostly superceded by sources with magnetic fields near the target. Three significant effects resulted: the target shapes are now disks, tubes, or rectangles; electron loss from the plasma is reduced; and the electron's path length is increased. The resulting *magnetron* sputter source's denser plasma greatly increased deposition rates and target utilization.

RF/DC/pulse DC Sputter Power Supplies

Electrically conducting metal, alloy, and compound targets cause no ion charging issues and are sputtered with DC power. Sputtering a material with poor electrical conductivity using DC power leads to charge buildup. Energetic ions are buried in the target's surface, but its resistivity prevents neutralization by electrons from adjacent electrodes. The target charge acts as an electrical barrier preventing further ion bombardment. Poor electrical conductors are sputtered using RF or pulsed DC power. The RF's reversal of electrode polarity or the negative surface bias present during the pulsed DC's "off" period causes the highly mobile electrons from the plasma to flood and neutralize the surface quickly.

Regular/Reactive Sputtering

The designation *regular/reactive* differentiates (regular) sputtering with inactive Ar gas and reactive sputtering with a gas mixture such as Ar/O2 or Ar/N2. Reactive sputtering has two important applications: (1) when target and film must have different chemical composition (e.g., sputtering a Ti target in Ar/N2 to give TiN films); and (2) when a compound target decomposes during sputtering and its stoichiometry (see **Stoichiometry**) must be restored.

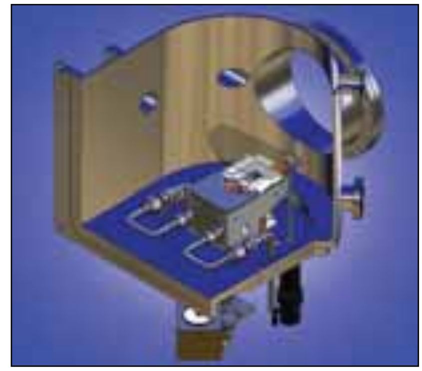
Balanced/Unbalanced Sputtering

If the central and outer magnets in a magnetron sputter source have similar strengths, then the flux lines from one pole will all terminate at the other pole. This arrangement is called a *balanced* magnetron and is the most commonly used. By contrast, if the outer magnets are stronger than the central magnet, some fraction of the flux lines do not terminate at the other pole and an *unbalanced* magnetron is created. The additional flux, roughly perpendicular to the target, passes through the substrate.

Electrons spiraling along these field lines are lost from the plasma; there are, however, beneficial effects with an insulating substrate. The electrons make ions in the process gas near the substrate. In addition, those electrons hitting the substrate give it negative bias. The result is that the substrate's surface is bombarded by ions that help density the film as it deposits. This is a form of ion-assisted deposition (IAD) (see IAD). The unbalanced magnetron disadvantage is that its less-dense plasma lowers target utilization and sputter rates.

E-Beam Evaporation
Regular/Reactive Evaporation

In e-beam evaporation, free electrons generated by thermionic emission from a filament hit the evaporant's surface. Dissipation of the high-energy, high-current beam causes a temperature rise and, at a suitable vapor pressure, a plume of evaporant.



Under regular e-beam evaporation, the chamber pressure is as low as possible to prevent chemical reaction with the film or bulk evaporant. Under carefully controlled partial pressures of reactive gases, *reactive* e-beam evaporation gives films of different chemical composition to the bulk material.

> ### *Evaporation vs. Sublimation*
>
> Almost all information about thin film deposition characterizes material transfer from bulk-to-film as *evaporation*. The correct usage of *evaporation* covers the "change of state" from a *liquid* to gas. A "change of state" from a *solid* to gas should be called *sublimation*. In general thin film work, however, the physical state of the bulk material is of little consequence and is probably unknown. Throughout these Tech Notes, the word *evaporation* covers both phenomena.
>
> A common misconception is that an evaporant's vapor pressure somehow changes markedly during a transition from sublimation to evaporation. That is, a solid evaporant at its melting point has a different vapor pressure when compared to the liquid form at its melting point. This is simply not true—for any material, the vapor pressure versus temperature curve is smooth at all temperatures. To give an example from everyday experience: in a glass containing ice cubes and water at 0° C, both phases have exactly the same vapor pressure.

Thermal Evaporation

Thermal evaporation is a major thin film deposition technique, particularly in R&D applications where the low installation costs and inexpensive, disposable evaporant "containers" are clear advantages. The shapes and sizes of the *boats*, *boxes*, *crucibles*, *baskets*, *filament*, etc., can be seen in **Section 9**. The disadvantages are precise temperature control may not be simple, and refractory metals sometime alloy, unexpectedly, with evaporants (e.g., evaporating Al from a W boat).

Effusion Cell Evaporation

Effusion cells come in many different designs classed as *near-ideal*, *open-tube*, *conical*, *nozzle-jet*, *point-source*, etc., with different names (including Knudsen cells, K-cells, and proprietary names). The main differences between them are beam intensity (which affects film deposition rate) and angular distribution (which determines film thickness uniformity). Good explanations of effusion cell characteristics are found in Chapter V of J.E. Mahan's book *Physical Vapor Deposition of Thin Film* (2000) together with Chapter 1 of Maissel and Glang's book *Handbook of Thin Film Technology* (1970).

High-Temperature Effusion Cells

Many elements and some inorganic compounds attain VPs suitable for fast deposition between 600° C and 1500° C. Effusion cells, which are essentially ceramic or carbon crucibles heated by external resistance or induction heaters, are a popular choice in this temperature range. Temperatures can be well-controlled, giving stable deposition rates, and the crucible holds moderately large volumes of evaporant.

Low-Temperature Effusion Cells

In the last decade, a huge interest has developed in electrically conducting organic films for displays and circuits. The evaporation temperature range for these materials is 200° C to 500° C. Neither resistive thermal sources nor "high-temperature" effusion cells provided adequate thermal stability, and a new class of effusion cells, specifically designed for this low-temperature range, has been developed.

Pulse Laser Deposition (PLD)

This is a *flash evaporation* technique. A short, high energy pulse from an eximer laser strikes the solid's surface. The fraction of energy absorbed creates a thermal pulse that rapidly spreads into the bulk evaporant, perpendicular to the surface. A directed plume completely vaporizes a thin "layer." The technique is particularly successful at producing stoichiometric films of complex compounds, for example: high T_c superconductor YBCO; bio-compatible calcium hydroxy-apatite; and alloys with components that have very different VPs. A good introduction to many aspects of pulse laser deposition is given in Mahan's book noted earlier.

Ion Beam Sputtering

Essentially, ion beam sputtering is a version of diode sputtering. In place of the normal plasma, a variable energy, wide ion beam source provides ions that are accelerated toward the target. The target and substrate are typically parallel with the ions injected at 45°. Ejected target atoms deposit on the substrate as a film. Using an active background gas, reactive ion beam sputtering is also possible. The technique has been very successful in applications requiring thin films of magnetic materials. (The magnetic fields of normal magnetron sputter sources are partially or completely shunted by magnetic targets. Only magnetrons equipped with very high strength magnets will operate.)

Chemical Vapor Deposition (CVD)

CVD (chemical vapor deposition) is a primary thin film deposition process in the semiconductor industry. Various CVD techniques are identified by groups (initial letters), for example: MOCVD (metal organic); PECVD (plasma enhanced); PACVD (plasma-assisted); APCVD (atmospheric pressure); LPCVD (low pressure); UHVCVD (ultrahigh vacuum); etc. Chapter 7 of D.L. Smith's book *Thin Film Deposition—Principles and Practice* gives an extensive description of general CVD processes and practices.

The initials in each case give an indication of a major operational characteristic. For example: MOCVD is basically the thermal degradation of a volatile metal-organic vapor. However, both "M" and "O" have liberal interpretations since MOCVD covers Si/Ge deposition and includes hydrides and carbonyls as the "organic" part. The chemistry, in particular MOCVD process, can be complex, involving pyrolysis, oxidation, hydrolysis, reduction, and displacement. In another example, PECVD, while similar to MOCVD, uses microwave or RF-generated plasmas in the vapor to facilitate a desired chemical change. Films form at lower substrate temperatures, making PECVD the preferred technique for films or substrates that are temperature sensitive. One important semiconductor processing application of PECVD is making silicon oxynitride films.

Film Structure/Properties

Alternative ways of categorizing thin film deposition describe the film's structure or the focus on techniques that improve the film's properties.

Morphology

The atomic- and nanometer-level structure of a deposited film has a profound influence on its chemical, optical, mechanical, electrical, and magnetic properties. The word *morphology* is a general description for this low-level structure. A film's detailed morphology depends on many factors present during the film's growth, including: chemical/physical properties of the depositing material; substrate temperature, flatness, and contamination; deposition rate; process or residual gas pressure; surface diffusion; film growth mode; residual stress in the film; and match between the film's and substrate's lattice parameters. Chapter 5 of Smith's book, mentioned earlier, gives a particularly good description of film morphology considerations.

Stoichiometry

Stoichiometry issues arise when depositing films of chemical compounds. Known rules cover the proportions in which elements combine to form compounds. For example, zinc oxide has the formula ZnO. However, depositing a film from bulk ZnO using (regular) sputtering or thermal evaporation causes oxygen loss, giving the film a stoichiometry of ZnO_{1-x}. That is, it is a mixture of ZnO and some portion of free metal. To correct this loss, a *reactive* deposition form with additional oxygen is used.

Zinc oxide's lack of stoichiometry during film deposition is well established. However, the range of oxides, sulfides, etc., that give non-stoichiometric films is not widely recognized and frequently is the source of variable or "weird" film properties.

Uniformity

A film's thickness is frequently critical to desired performance. For example, anti-reflection coatings, giant magneto-resistance devices, neutron beam guides, and optical filters will not function without the correct film thickness. Equally important is the uniformity of that thickness across the area of interest. With the exception of atomic layer deposition (see ALD), all deposition techniques can produce films with some level of non-uniformity. Approaches to reducing thickness variations in PVD methods include optimizing the bulk material's throw distance to the substrate, substrate rotation, and/or planetary motion. For CVD methods, the approaches include laminar "showerhead" gas introduction and substrate rotation.

Thin-Film Deposition

A few examples of products that would not exist, or be as effective, without vacuum thin film deposition processes.

- **Consumer:** CDs and DVDs; aluminized plastic food packaging; camera lenses; mirrors; optical coatings for windows, glasses, and sunglasses
- **Commerce:** Computer hard drives and GMR read heads; headlamp reflectors; architectural glass; tool hard-coatings; diamond-like films; semiconductor chip production; organic electronics and displays; transparent conducting layers; magnetic memory; advanced solar panels; MEMS accelerometers
- **Military:** Aircraft canopies; night vision goggles; FLIR vision devices
- **Medical:** Eximer lasers for eye surgery; passivated prosthetic joints; coated stints; super-insulation for MRI magnets
- **Research:** Neutron beam guides; laser mirrors; optical filters; super-lattices; rugates; high/low T_c superconductors; SQUID magnetic detectors; quantum dots

Ion Assisted Deposition (IAD)

IAD uses a wide-diameter inert gas ion gun to provide relatively low-energy impact on a film being deposited by evaporative or sputter techniques. The technique is well established for high-quality optical coatings where it modifies intrinsic film stress, improves film adhesion, and reduces porosity (densifies). The last one reduces moisture adsorption, and hence vacuum- to-air shifts. But in all, IAD enables production of multilayer optical components with low absorption and stable refractive indexes

Atomic Layer Deposition (ALD)

ALD is a self-limiting CVD process that is rapidly becoming the preferred technique for depositing high-k dielectric oxides. The growth of a metal oxide consists of two reaction steps. In the first, the metal compound precursor reacts with the surface, and in the second it reacts with some source of oxygen. Between steps, a purge gas removes excess metal compound precursor and reaction by-products. An example is the ALD deposition of aluminum oxide where the overall reaction $2Al(CH_3)_3 + 3H_2 = Al_2O_3 + 6CH_4$ is split into two steps:

1. $AlOH^* + Al(CH_3)_3 = AlOAl(CH_3)_2^* + CH_4$
2. $AlCH_3^* + H_2O = AlOH^* + CH_4$

where * indicates the surface species.

Alternating pulsing the metal precursor and the oxidant with gas purges between them enables precise multiple layer formation. Although MOCVD is a faster process, ALD's surface reaction nature (without a gas-phase component) gives superior step coverage and film uniformity. ALD is particularly suitable for surfaces containing "trenches" or "vias."

Combinations

Combined Techniques

Typically, there is a preferred deposition technique for each material and type of film required. A very involatile element or compound may make thermal evaporation unfavorable. Perhaps the element responds to DC sputtering and the compound to RF/pulse DC sputtering or reactive DC sputtering. There are, however, many elements and compounds for which thermal or e-beam evaporation is preferred. Practical deposition systems are frequently made more versatile by installing two or more different techniques in the same chamber. In such an arrangement, a process requiring both evaporation and sputtering for co-deposition, or sequential deposition, is done without substrate re-location or breaking vacuum.

Rather than different techniques, some applications need multiple examples of the same technique. This is particularly true of sputtering, where up to nine guns have been mounted in one chamber, or effusion cells for organic materials, where as many as ten cells have been installed in one chamber.

One critical aspect of multiple or combined techniques in one deposition system is "cross-talk". The "plume" of one material must not deposit on (and contaminate) the material in a separate deposition source. This is achieved by careful design of sources, shields, shutters.

With the exclusion of ALD, all evaporation sources are mounted with the vapor plume's axis vertically up. This avoids spillage if the material is molten at its evaporation temperature.

Sputter source targets never melt and the source's orientation is un-restricted. Two common arrangements for multiple sputter sources are "parallel" and "convergent". Parallel sources have their axes (the normal to the target plane's surface) parallel. This is a common arrangement in box coaters where a number of substrates is mounted on a rotating platen and the platen moves to locate a substrate's center over each source's center in turn. This arrangement suits sequential layer deposition. Convergent sources have axes that meet at a point in space that coincides with the substrate surface's center-point. This arrangement is particularly useful when co-depositing different materials.

Combined Chambers

One common chamber combination is a load lock (LL) and main chamber (MC). The small volume LL has its own pumping system and O-ring sealed door. It is connected to the MC by a large diameter gate valve. A substrate is loaded into the vented LL which is then pumped. When the LL is at high vacuum, the gate valve is opened and the substrate is mechanically transferred into the MC (which remains at high vacuum throughout the transfer stage). Some LLs are fitted with heater stages, plasma cleaning devices, or other substrate preparation devices so the "gassy" processes do not contaminate the main deposition chamber.

More complex combinations interconnect UHV chambers for, perhaps, MBE deposition and surface science analysis, or high vacuum chambers for plasma etching, metal deposition, organic deposition, mask storage, etc., in a cluster arrangement. Of recent interest is the combination of an ALD chamber (isolated by a gate valve and suitable substrate transporter unit) and a PVD chamber, allowing the overlaying of different film types.

The recent huge increase of interest in: reactive metal films; organic electronics films; and light-emitting organic displays (OLEDs), has led to strong growth in another chamber combination. The issue here is, these film cannot be exposed to the atmosphere without a protective coating or sealing. These coating/sealing operations are however, not vacuum operations but are done under an inert gas. This led to a demand for glove boxes interfaced to load locks. The films are transferred from the LL to glove box under positive argon atmosphere and are sealed/coated before venting the glove box to air.

Vapor Pressures & Melting Points

Two firmly held convictions exist when discussing evaporation as a thin film technique.

An element's equilibrium vapor pressure (VP) is related to its melting point.

Al and Mg melt only 10° C apart, yet have VP that differ by a factor of 10^9. Although Gd and Ga melt over 1280° C apart, at the same temperature their vapor pressures are roughly a factor of 20 different.

Yes, if one assumes an acceptable evaporation rate requires a VP of 1×10^{-2} Torr and plots the temperature needed to reach this VP versus melting point, the result for some elements is a quasi-straight line. However, a quick count shows ~23 elements of interest in deposition deviate by having VPs 100 times higher or lower at their melting points.

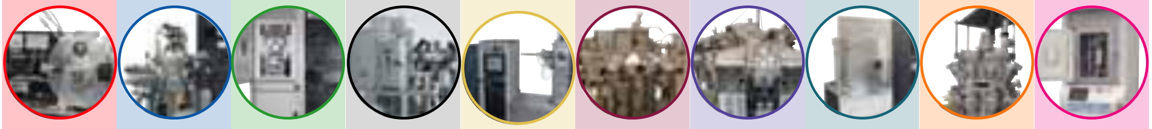
Yes, a few alloys (e.g,. Ni/Cr 80/20%) evaporate, giving films with almost the bulk alloy's stoichiometry. But the VPs of Ni and Cr are less than one decade apart at any temperature. In addition, chromium's slightly higher VP probably compensates for its lower mole fraction (actually its activity in the evaporating bulk). By contrast, any alloy of Al/Mg would always give a greatly enriched Mg film.

Two pairs of metals demonstrate how wrong these convictions are.

Metal	Melting Point ° C	VP at M.pt Torr
Al	660.32	3×10^{-9}
Mg	650	3
Gd	1312	1×10^{-2}
Ga	29.76	10^{-20}
Ga	(at 1312)	2×10^{-1}

➤ System Selection Guide

Use this chart to locate a standard system platform suited for your application.



	Platforms									
	AXXIS™	***CMS Series*** CMS-18™, CMS-24, LAB 18	***PVD Series*** PVD 75™, PVD 225, PVD 250, PVD 500	***ALD Series***	***SPECTROS***® Mini-SPECTROS Super-SPECTROS	***LUMINOS***®	***OCTOS***®	***Box Coaters***	***Custom Designed***	***NANO 38***
	HV See pages 15-8 to 15-9	**HV or UHV** See pages 15-10 to 15-12	**HV** See pages 15-14 to 15-15	**HV** See pages 15-24 to 15-25	**HV** See pages 15-16 to 15-19	**HV or UHV** See pages 15-20 to 15-21	**HV or UHV** See pages 15-22 to 15-23	**HV or UHV** See pages 15-10 to 15-12	**HV or UHV** See pages 15-27 to 15-28	**HV** See pages 15-13
Deposition Techniques*										
Magnetron Sputtering	✔	✔	✔	—	✔	✔	✔	✔	✔	✔
Thermal Evaporation	✔	✔	✔	—	✔	✔	✔	✔	✔	✔
ALD	—	—	—	✔	—	✔	✔	—	✔	—
E-Beam Evaporation	✔	✔	✔	—	—	✔	✔	✔	✔	—
OLED Sources	—	—	✔	—	✔	✔	✔	✔	✔	✔
➤ ***Multi-Technique*** Techniques (above) can be combined	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
System Configurations*										
Multiple-Chamber System	—	—	—	✔	—	✔	✔	—	✔	—
Load-Lock Interfaceable	✔	✔	✔	✔	✔	✔	✔	✔	✔	—
Glove Box Interfaceable	—	—	—	✔	✔	✔	✔	—	✔	—
Cluster Tool	—	—	—	—	—	✔	✔	—	✔	—

Note: Listed options may not be available depending on specific configurations. Contact our Process Equipment Division at* ***ped@lesker.com* *for more information.*

➤ AXXIS™

AXXIS™—Facilitates multiple deposition techniques and co-deposited films efficiently!

The University of Alberta uses our AXXIS for glancing angle depositions (GLAD).

Typical Applications

- *R&D Thin Film Deposition*

Deposition Techniques Available

- *Magnetron Sputtering (RF, DC, or Pulsed DC)*
- *Electron Beam Evaporation*
- *Thermal Evaporation*

Process Options

- *Heating*
- *Cooling*
- *Bias*
- *Ion Source for Substrate Cleaning/Assisted Deposition*

Custom system with optional load lock

Optional service well mounted electron beam source

Inside custom chamber assembly with rear-mounted substrate fixture

➤ AXXIS™

AXXIS™ Features

- 18" diameter x 15" deep cylindrical 304 stainless steel chamber
- Six radial process ports
- Hinged front-loading door
- Door- or port-mounted substrate fixtures
- Turbomolecular or cryogenic pumping
- Available with up to six TORUS® circular magnetron sputtering sources
- Available with up to 6-pocket 5.5kW electron beam source
- Available with up to three thermal evaporation sources
- Optional ion source
- Open framework
- Instrument rack

Optional

- Substrate fixture indexing and rotation
- Load lock
- Computer-controlled process automation

➤ CMS Series

CMS Series—Versatile thin film deposition systems for advanced materials research and development

The Chinese Academy of Sciences Institute of Physics uses our CMS-18™ for advanced GMR/TMR research.

Typical Applications

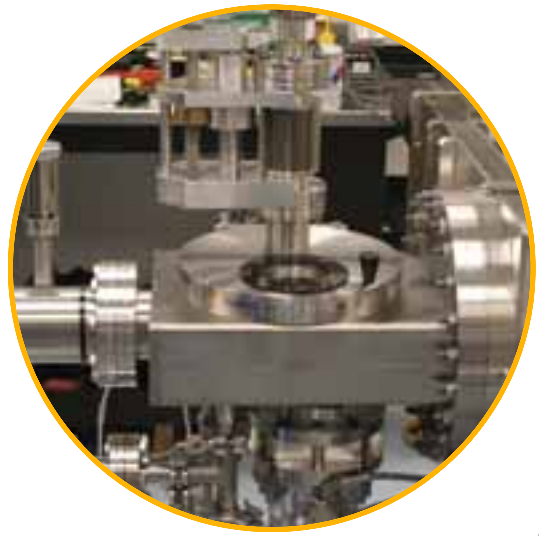
- *R&D Thin Film Deposition*

Deposition Techniques Available

- *Magnetron Sputtering (RF, DC, or Pulsed DC)*
- *Electron Beam Evaporation*

Process Options

- *Symyx® Licensed CMS package*
- *Heating*
- *Cooling*
- *Bias*
- *Indexable Magnetic Field*
- *Ion Source for Substrate Cleaning/Assisted Deposition*



Optional load lock with custom cooling stage

■ CMS-18 & CMS-24

Performance-oriented design for advanced university, industrial, and government lab R&D applications.

- 18" diameter x 15" wide cylindrical chamber (CMS-18™)
- 24" diameter x 15" wide cylindrical chamber (CMS-24)
- Available with up to six source ports (standard)
- Available with up to six TORUS Magnetron Sputtering Sources
- Available with multi-pocket electron beam evaporation source
- Accommodates substrates up to 8" (CMS-18 up to 6")
- Available with 3 cm filamentless ion source

➤ CMS Series

CMS Series Common Features

- Cylindrical 304 stainless steel chamber
- Chamber top plate assembly with hoist
- Up to six TORUS® magnetron sputtering sources
- Turbomolecular or cryogenic pumping
- Manual touch-screen or computer-controlled process automation
- Substrate fixture with rotation
- Substrate load lock
- Extruded aluminum system support frame

➤ CMS Series

LAB 18

New economical design geared toward R&D applications for the budget-conscious.

Features

- 18" high x 20" wide cylindrical chamber
- Available with up to 5 source ports (standard)
- Available with up to 5 TORUS® Magnetron Sputtering Sources
- Available with multi-pocket electron beam evaporation source
- Available with multiple thermal evaporation sources
- Accommodates substrates up to 4"

➤ NANO 38

Our NANO 38 deposition system is a compact, low cost evaporator or Sputter Deposition System able to facilitate sequential depositions. Its simple, full enclosure design is based on the success of our PVD 75 system and includes an integrated touch-screen controller.

Features

- 18" high x 12" deep/wide D-shape 304 stainless steel chamber
- Aluminum door with rectangular viewport
- 3-pocket thermal evaporator with standard 2 kW power supply
- Fixed substrate fixture (platen)
- Turbomolecular pumping
- Integrated touch-screen controller and film monitor
- Fully enclosed "zero" clean room footprint design

Options:

- Thin film monitor or controller
- Motorized rotating substrate fixture
- Pneumatic deposition shutters
- Magnetron sputtering sources

➤ PVD Series

PVD Series—Modular design configured to suit a variety of thin film deposition applications, typically for research and development or small batch production.

Leading medical device manufacturers use our PVD line of systems to produce biocompatible films.

Typical Applications

- *R&D Thin Film Deposition*
- *Small Batch Production*

Deposition Techniques Available

- *Magnetron Sputtering (RF, DC, or Pulsed DC)*
- *Electron Beam Evaporation*
- *Thermal Evaporation*
- *Organic Evaporation, Including OLED/PLED and Organic Electronics Applications*

Process Options

- *Heating*
- *Cooling*
- *Bias*
- *Ion Source for Substrate Cleaning/Assisted Deposition*

Optional computer-controlled process automation

PVD 75™, PVD 225, & PVD 250

Designed for university, industrial, and government lab R&D applications.

- 24" high x 14" wide/deep D-shape (PVD 75)
- 30" high x 24" wide/deep D-shape (PVD 250)
- Fully enclosed "zero" clean room footprint mounting
- Available with up to 4 TORUS® circular magnetron sputtering sources
- Available with multi-pocket electron beam evaporation source
- Available with multiple thermal evaporation sources
- Available with up to 6 low-temperature organic evaporation sources
- Available with 3cm filamentless ion source system

PVD 500

Spacious chamber design ideal for use as a production box coater requiring high throughput.

- 30" high x 32" wide/deep D-shaped 500-liter chamber
- Available with up to 6-pocket 10kW electron beam source
- Available with multiple TORUS production-scale magnetron sputtering sources
- Available with 5cm or 10cm filamentless ion source

Optional

- Fully enclosed "zero" clean room footprint mounting

➤ PVD Series

PVD Series Common Features

- D-shape 304 stainless steel chamber
- Aluminum door with large viewport
- Turbomolecular or cryogenic pumping
- Manual touch-screen or recipe-controlled PC based process automation
- Single, multiple, or custom substrate fixtures

Optional

- Planetary substrate fixture
- Load lock

Kurt J. Lesker Company

➤ SPECTROS®

SPECTROS®—Designed for device fabrication research of OLED/PLED materials used in display and lighting applications.

Imperial College London uses our SPECTROS to deposit organic films for cutting-edge photovoltaic research.

- *Computer controlled, single-chamber R&D system*

Typical Applications

- *OLED/PLED R&D and Device Fabrication*
- *Organic Electronics*
- *Organic Flat Panel Lighting*

Deposition Techniques Available

- *Thermal Evaporation of Inorganics, Including Metals*
- *Thermal Evaporation of Small Molecule Organics*

Process Options

- *Substrate Heating*
- *Mask Changing*
- *Glove Box Interface*

Shuttered organic sources

Custom 12 LTE organic source array with integral flip shutters

Mask shelves

➤ SPECTROS®

SPECTROS® Features

- 18" diameter x 36" high 304 stainless steel chamber
- Sliding front door with glove box interface flange
- Turbomolecular or cryogenic pumping
- Available with up to 8 low-temperature organic material evaporation sources
- Available with up to 3 metal evaporation sources
- Up to 4" x 4" (100mm x 100mm) substrates
- Substrate/mask array with ±12.5 μ positional reproducibility
- Manual mask changing
- Fully computer-controlled process automation
- CE Approved

Optional

- Glove box with gas purification system
- Automated mask changing
- Substrate heating to 200° C

➤ SPECTROS®

Mini-SPECTROS

- 15" wide x 15" deep x 24" high rectangular chamber
- Sliding front door with glove box interface flange
- Hinged o-ring sealed rear door for easy chamber access
- Available with up to 4 low-temperature organic material evaporation sources
- Available with up to 2 metal evaporation sources
- Up to 4" x 4" (100mm x 100mm) substrates
- Turbo molecular or cryogenic pumping
- Fully computer-controlled process automation
- CE Approved

Optional

- Glove box with gas purification system
- Substrate heating to 200° C

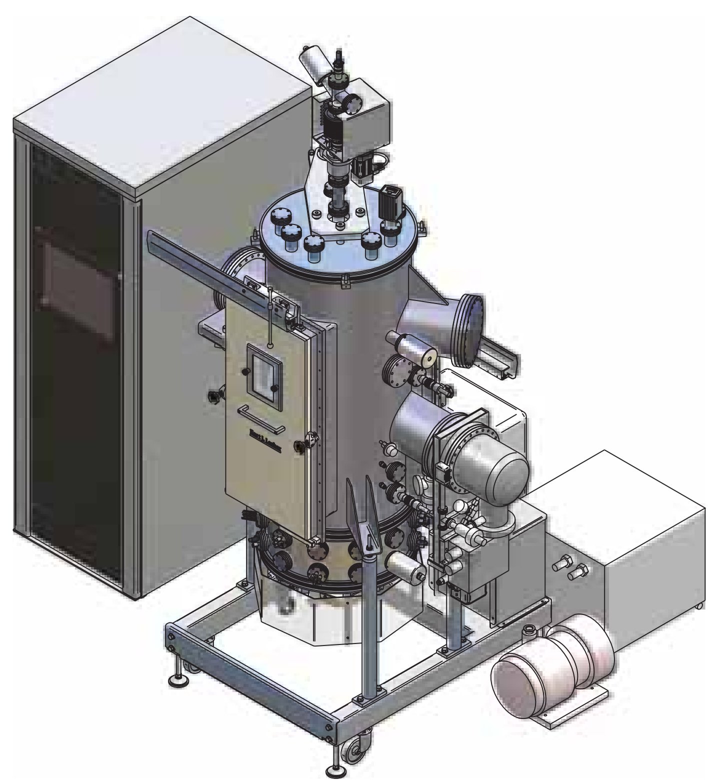
NOTE: For our standard chambers please refer to www.lesker.com for downloadable Adobe PDF 2D Dimensional Drawings, Engineering Files in DXF (2D), STP (3D) formats, and interactive 3D models which enable users to rotate, zoom, and much more.

Super-SPECTROS 150

- Cylindrical chamber
- Large sliding o-ring sealed front door with glove box interface flange
- Small hinged o-ring sealed rear door
- Available with up to 8 low-temperature organic material evaporation sources
- Available with up to 3 metal evaporation sources
- Up to 6" x 6" (150mm x 150mm) substrates
- Turbo molecular or cryogenic pumping
- Fully computer-controlled process automation
- CE Approved

Optional

- Glove box with gas purification system
- Substrate heating to 200° C
- Automated mask changing
- Wedge shaped film growth tool
- Sliding rear door

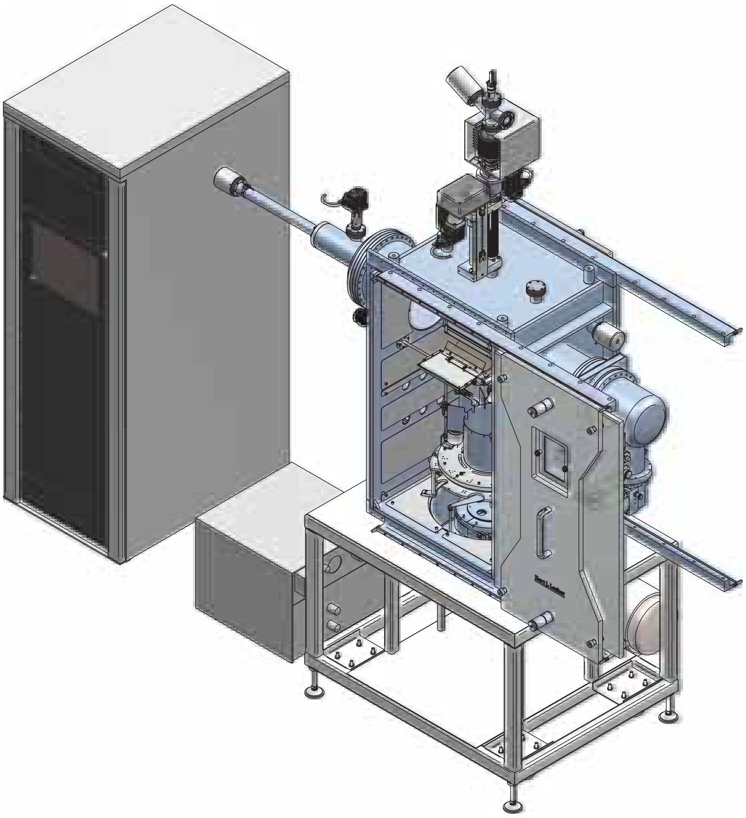


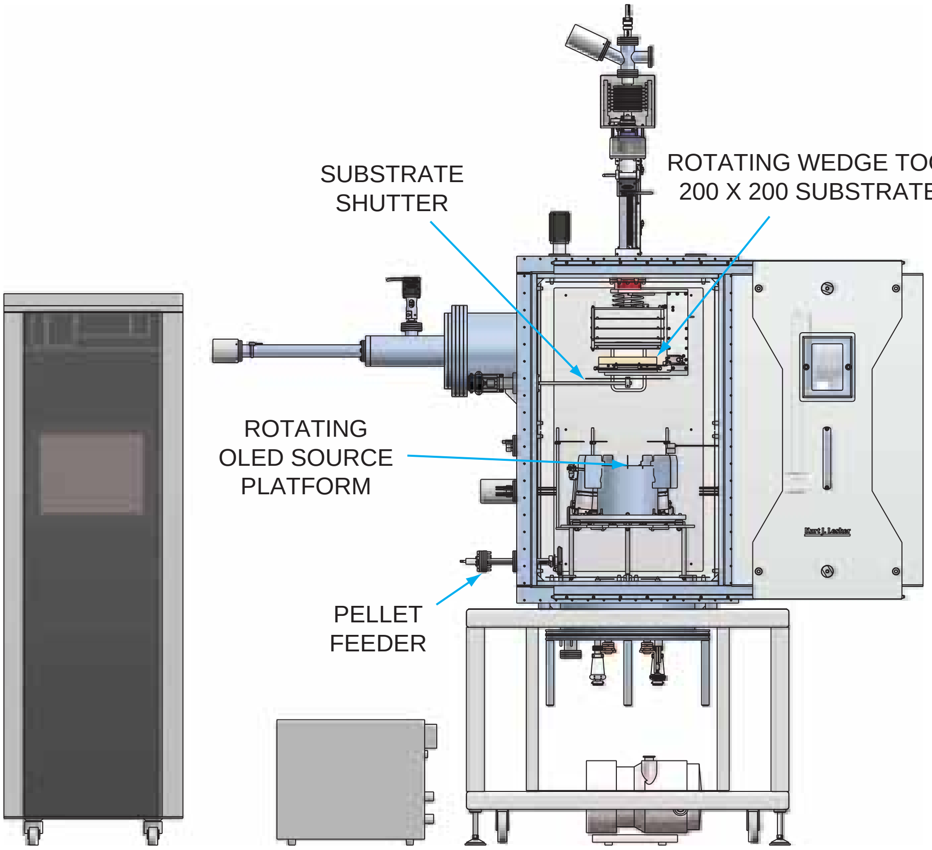
Super-SPECTROS 200

- 24" wide x 24" deep x 40" high rectangular box chamber
- Large sliding O-ring sealed front door with glove box interface flange
- Large lading O-ring sealed rear door with glove box interface flange
- Available with up to 14 low-temperature organic material evaporation sources
- Available with up to 4 metal evaporation sources
- Up to 8" x 8" (200mm x 200mm) substrates
- Turbo molecular or cryogenic pumping
- Fully computer-controlled process automation
- CE Approved

Optional

- Glove box with gas purification system
- Substrate heating to 200° C
- Automated mask changing
- Wedge shaped film growth tool
- Aluminum pellet feeder





Kurt J. Lesker Company

➤ LUMINOS®

LUMINOS®—Multi-chamber thin film deposition and analysis manual cluster tool system for R&D applications requiring in-vacuum substrate transfer between chambers.

Penn State University uses our LUMINOS to deposit multi-layered PVD and CVD thin films.

- *Radial Distribution Center Chamber enables 6 to 8 process modules to be connected, accommodates substrates up to 4" x 4"*

Typical Applications

- *Multi-Chamber for OLED/PLED R&D*
- *Multi-Chamber for Device Fabrication*
- *Thin Film Deposition and Analysis*

Deposition Techniques Available

- *Magnetron Sputtering (RF or DC)*
- *Thermal Evaporation of Metals & Inorganics*
- *Thermal Evaporation of Organics, Including OLED/PLED Applications*
- *ALD*
- *Electron Beam Evaporation*

Process Options

- *Heating*
- *Cooling*
- *Bias*
- *Ion Source for Substrate Cleaning/ Assisted Deposition*

Integrated touch-screen computer controlled software

System Assembly & Test Capabilities

For over 20 years we have designed, manufactured, assembled, programmed, and tested hundreds of thin film deposition systems for both research and production applications. Our four clean assembly areas, located at our US and UK facilities, provide the necessary environment for system assembly and testing. All seals, welds, flanges, and chambers are helium leak checked and inspected to ensure vacuum integrity prior to system assembly. These components are then professionally assembled by our technicians using protective wear to prevent contamination. Our on-site fabrication shops offer immediate support for any necessary modifications during assembly. Functional testing of the completed systems to standard procedures and customer specifications ensures reliability and customer satisfaction. We offer on-site system start-up and customer training for any of our systems to get your process up and running—quickly and efficiently. Refer to **page16-10** for more information on our manufacturing capabilities or contact our Process Equipment Division at **ped@lesker.com**

➤ LUMINOS®

LUMINOS® Features

- Substrate entry and exit load lock and sample preparation chamber
- Radial Distribution Center (RDC) Chamber
  - – 304 stainless steel 8-way 36" diameter chamber
  - – Manual rotary sample transfer device
  - – Motorized linear and Z-shift sample transfer devices
  - – Pneumatic isolation valves between radial process chambers
- Organic Evaporation Chamber
  - – Available with up to 9 low-temperature organic evaporation sources
- Metal Evaporation Chamber
  - – Available with up to 4 thermal evaporation sources
- Mask-Changing Module
  - – Manual Z-shift sample transfer device for mask exchange
  - – 10-mask storage capacity with mask holders

Optional

- Sputter deposition chamber
- Reactive plasma cleaning chamber
- Computer-controlled process automation

➤ OCTOS®

OCTOS—A fully automated cluster tool for pilot production scale processing of substrates requiring in-vacuum substrate transfer between chambers

Leading display device manufacturers use our OCTOS to advance OLED technologies.

- *Offers exceptional layer thickness uniformity, repeatability, and reliability sought by OLED/PLED and GMR customers alike*

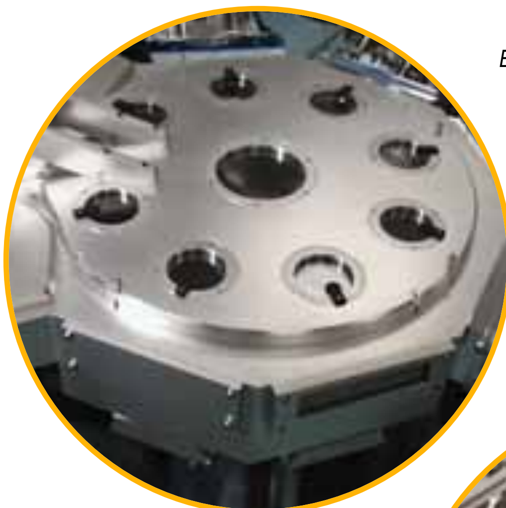
Entry load lock with servo-controlled vertical indexer

Typical Applications

- *OLED/PLED R&D or Production*
- *GMR Magnetic Films R&D or Production*
- *Photovoltaic R&D or production (PV, OPV)*
- *Organic Electronics*

Deposition Techniques Available

- *Magnetron Sputtering (RF, DC, or Pulsed DC)*
- *Thermal Evaporation, including Metal Inorganic Evaporation*
- *Organic Evaporation, including OLED/PLED, organic photovoltaic, organic TFT applications*
- *ALD*
- *Electron Beam Evaporation*



Fully automated robotic sample transfer

Process Options

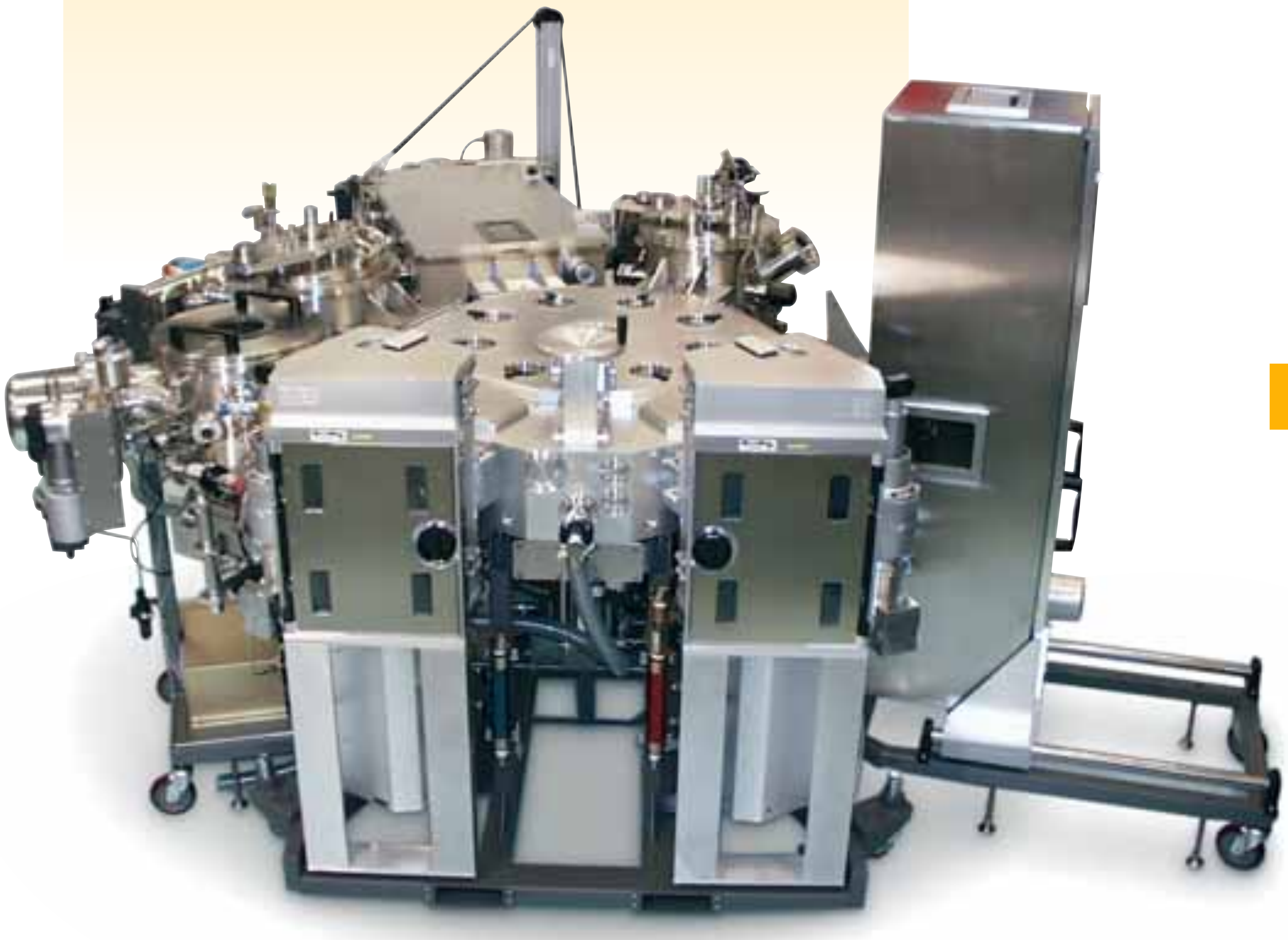
- *Heating*
- *Cooling*
- *Bias*
- *Ion Source for Substrate Cleaning/Assisted Deposition*
- *UHV Option*

Sputtering chamber for large area substrates

NOTE: For our standard chambers please refer to www.lesker.com for downloadable Adobe PDF 2D Dimensional Drawings, Engineering Files in DXF (2D), STP (3D) formats, and interactive 3D models which enable users to rotate, zoom, and much more.

OCTOS Features

- Automated entry and exit locks with multi-sample cassette
- Fully automated robotic sample transfer system
- Available with up to 6 process chambers for standard HV OCTOS platform
- Linear Sputtering Chamber
  – Available with Linear Magnetron Sputter Sources
- Organic Evaporation Chamber
  – Available with up to 9 low-temperature organic evaporation sources
- Metal Evaporation Chamber
  – Available with up to 4 thermal evaporation sources
- Reactive Plasma Chamber
  – Features parallel plate RF etching
- Mask-Changing Module
  – 20-mask storage capacity with mask holders



➤ ALD Systems & Components

ALD Series—We offer stand-alone ALD systems for basic research or completely integrated deposition systems for complex R&D applications. All of our ALD system platforms feature full process control, integrated pumping, pressure measurement, and gas delivery packages optimized for your specific process.

ALD-150L

Compact computer controlled system features a high performance, efficient viscous flow ALD reactor.

- Small footprint
- Stainless steel chamber
- Accommodates 6" substrates
- Heating to 500° C
- Heated lines to 200° C
- Remote plasma option
- Load lock/substrate transfer option
- Bubbler option - with closed loop control
- Fully exhausted cabinet

ALD-200L

Computer controlled rack-sized system which supports advanced ALD research.

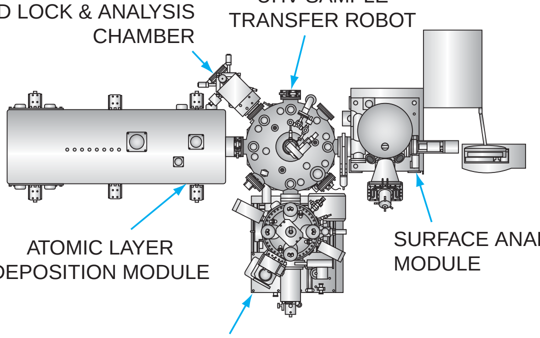
- Featuring a viscous flow ALD reactor
- Enclosed design accommodates a large number of reactant inputs
- Chamber accommodates up to 8" substrates
- Heating to 500° C
- Fully exhausted cabinet with gas interlocks
- Remote plasma option
- Load lock substrate transfer option
- Bubbler option - with closed loop control

➤ ALD Systems & Components

ALD-8000

Fully integrated computer controlled system supports a wide range of process enhancements and metallurgy tools to complement our ALD reactor - all within the vacuum environment.

- Fully exhausted cabinet with gas interlocks
- Stainless steel chamber
- Up to 8" substrates with up to 500° C heating
- Heated lines to 200° C
- Maximum number of reactants and gas inputs
- Full in-vacuum transfer capability through central distribution center to connected system and processes



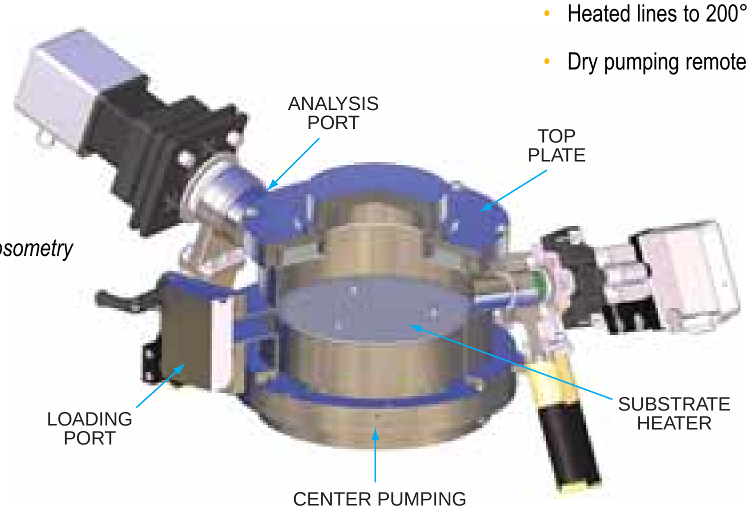
ALD Reactant Chamber Design

The Kurt J. Lesker Company®'s ALD reactant chamber is designed for fast cycle times and maximum flexibility. The sample is loaded through a rectangular port in the chamber (either manually or utilizing the optional load lock) and positioned in the reactant chamber where the deposition takes place. Up to four precursor or gas inputs are introduced through the top plate. A fifth input is available through the plasma port.

- Stainless steel construction
- Front loading port
- Close proximity back side heating to 500° C
- Substrates from small irregular pieces up to 200mm wafers
- Analytical ports in reactor for in-situ analysis
- Remote plasma option for low temperature process
- Top mounted vapor delivery
- Curtain gas flow design to speed cycle time and to minimize contamination on reactor walls and ellipsometry to reduce unwanted side reactions

Optional

- Vacuum load lock
- Remote plasma source
- In-situ
- RGA system
- Ellipsometry package
- Bubbler
- 500° C substrate heating
- Chamber heating to 150° C
- Heated lines to 200° C
- Dry pumping remote with plasma source



Kurt J. Lesker Company

➤ Clean Vacuum Oven System
➤ Clean Vacuum Furnace System

CVO400 - Clean Vacuum Oven System

The CVO400 is an ultra clean vacuum oven featuring computer-controlled operation with heating to 450° C. Typical applications include heat treating, degas and conditioning of parts and components

Features

- 450° C Operating Temperature
- Turbomolecular Pumping
- Quartz Lamp Hot Zone
- Touch Screen Control with Recipe Driven Procedures and Data Logging

Options:

- Stainless Steel Panels (Shown)

CVF1000 - Clean Vacuum Furnace System

The CVF1000 is an ultra clean vacuum furnace featuring computer-controlled operation with heating to 1000° C. Typical applications include brazing of metallics or ceramics, heat treating, and degas and conditioning of parts and components

Features

- 1000° C Operating Temperature
- Cryogenic Pumping
- Molybdenum and Inconel Hot Zone
- Fully automated touch Screen Control with Recipe Driven Procedures and Data Logging

Kurt J. Lesker Company has the experience and technology to develop your vacuum process solution.

We manufactured our first thin-film vacuum deposition system over 20 years ago at our U.S. headquarters in Pittsburgh, Pa. Hundreds of systems later our proven Process Equipment Division, with engineering, manufacturing, and clean-room assembly areas in the U.S. and U.K., are positioned to offer custom PVD and CVD deposition systems designed and manufactured to exacting specifications for your specific process application.

We can develop simple single-chamber bell jar systems for smaller R&D applications to complex multi-chamber computer-controlled cluster tool systems for OLED/PLED production, and everything in-between. Our systems can include a variety of deposition techniques, including magnetron sputtering (RF, DC, and Pulsed DC) sources in both linear and circular configurations, ion sources for substrate cleaning and assisted deposition, electron beam evaporation, thermal evaporation for metals and organics, and pulsed laser ablation.

Whether your process requires HV or UHV pressures, our Process Equipment Division delivers—from GMR and OLED/PLED R&D and device fabrication systems through industrial box coaters and space simulation systems.

Contact Us…

Contact our Process Equipment Division today at **ped@lesker.com** to discuss your specific process application needs.

Multi-chamber custom cathode test system

Computer-controlled industrial coating system

Electron gun test system

Glove box integrated OLED deposition system

Covering the World with Thin Film Deposition

Our systems are used by industries all over the world for various applications, including:

- Data Storage (GMR/TMR drives)
- Decorative Coatings (automotive, faucets, chandeliers, jewelry)
- Display Technologies (OLED/PLED devices, LEDs, laser diodes)
- Energy Conservation (solar cells, fuel cells, energy filters)
- Medical & Biomedical (implants, instruments)
- Optics (sunglasses, camera lenses, night-vision goggles, UV/IR filters)
- Physics Research (nanotechnology, spintronics)
- Semiconductor (silicon wafers)
- Sensor Technologies (automotive, aerospace, biotechnology)
- Superconductors (power transmission, magnetic levitation)
- Wear-Resistant Coatings (engines, turbines, tools, razor blades)

Multi-Chamber MOCVD and Magnetron Sputtering System