PRIMAXX

Liquid Source Misted Chemical Deposition System

for Complex Metal Oxide Thin Films

Patented technology for metal oxide thin film deposition ....

Liquid Source Misted Chemical Deposition (LSMCD) is a patented process for depositing high quality metal oxide films directly from liquid sources. This unique technology applies thin, conformal layers of liquid precursor on submicron features to form high quality films of ferroelectric, dielectric and opto-electronic materials. Major features and benefits of LSMCD tecnology include:

- Excellent results with MOD precursors
- High conformality and across-the-wafer uniformity
- Superior electrical properties for thin ferroelectric and high-k films of 50Å thickness and above
- Precise stoichiometric control
- Excellent wafer-to-wafer repeatability
- Precise curing temperature control for optimal perovskite crystal structure
- Low defect density for increased yields
- Small MESC cluster footprint saves cleanroom space
- Wide range of applications with liquid based materials
- Deposition over platinum or other electrode materials (See included periodic table)

Elemental oxides that can be utilized with LSMCD

Leaders in Complex Oxide Thin Film Technology

With the introduction of this unique, patented Liquid Source Misted Chemical Deposition system, Primaxx has demonstrated the ability to deposit complex metal oxide films directly from liquid sources. LSMCD offers many benefits over competing processes such as spin-on and sputtering since it provides good thickness and stoichiometry conformality over shallow surface features. LSMCD is particularly successful in depositing various MOD solutions for films of 50Å and above.

Drop distribution generated by Primaxx patented atomization technology

Liquid Source Misted Chemical Deposition (LSMCD)

LSMCD reduces the liquid chemical to an aerosol of submicron size droplets with precisely controlled diameters. Electrostatic and fluid forces in the LSMCD reactor transport the droplets to the wafer surface at essentially ambient temperature and pressure. These conditions preserve precursor stoichiometry and distinguish LSMCD from CVD methodologies. Primaxx cured films exhibit the optimal electrical and/or optical properties required for the successful use of ferroelectric, low-k, high-k and optical thin films in today's emerging devices.

Superior Performance

LSMCD technology is able to produce high quality thin films that not only exhibit excellent electrical properties, but also give good conformal coverage over surface features. The data summarized below show hysteresis and leakage current characteristics for 90 nm Strontium Bismuth Tantalate (SBT) films.

Because LSMCD yields excellent film conformality as well as eliminating voids around surface structures typically associated conventional spin-on technology, process yields can increase dramatically as illustrated below. Data are for a 100nm SBT film annealed at 700 degrees C.

LSMCD Film Conformality

Applications

Applications for LSMCD thin film technology include ferroelectric materials for memory and MEMS devices, magnetoelectric materials for memory devices, high k and low k dielectric materials and opto-electronic materials for LCD and projection products.

LSMCD has been used to successfully deposit SBT, Barium Strontium Titanate (BST), Lead Zirconate Titanate (PZT), Strontium Tanatalate (STO), Indium Tin Oxide (ITO) and other MOD materials onto a variety of substrates.

Superior performance, full-scale production capability ....

Production Cluster - A Turnkey System

The Primaxx LSMCD Cluster System is a fully integrated, environmentally isolated, automated cluster tool designed to deposit high quality, complex metal oxide thin films on 150 or 200 mm substrates. The toolset provides cassette-to-cassette wafer processing and is configured with a combination of LSMCD and RTA Module(s) to meet specific application and throughput requirements. The system also includes a Control Tower with ControlWORKS interface, an optional pre-clean module and these automation components:

- Input/Output Cassette Elevator Modules (25 wafers each).
- Wafer Transport Vacuum Chamber - 6-position, with high reliability robot. Robot has repeatable x, y, z precision positioning capability.
- Wafer Aligner for precise wafer alignment and orientation.
- Wafer Cooler quickly cools hot wafers before cassette placement.
- Electrical Cabinets to distribute and control system electrical power.
- Gas/Liquid Control Cabinet to control precursor liquid flows and pressures, and atomizer/chamber gas flows and pressures.

Easy Maintenance - Reactor Auto Clean Cycling

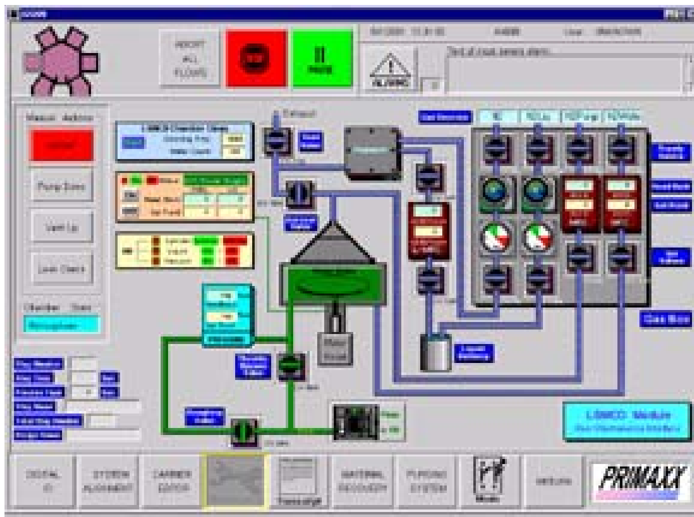
Although process and material dependent, on average reactor cleaning is only required every 25 wafers.

The Primaxx Auto Clean System injects cleaning solvent mist into the LSMCD reactor under partial vacuum, dissolving chemical residues and removing them without the use of particle creating materials. Vaporized solvent and chemical residue are pumped to the facility burn box and exhausted.

The Auto Clean function restores the LSMCD reactor to a condition where all process wafer specifications will be met (uniformity, particle count, deposition rate); the cycle runs automatically, based on a predetermined processed wafer count that is dependent on the film material and characteristics.

User Friendly Graphical Interface

Adventa ControlWORKS™ software presents the operator with a simple, yet high level, graphical user interface for integrated process control. Object oriented display screens allow recipe creation and editing, scheduling, alarm handling, and monitoring of system control elements.



LSMCD Cluster System Graphical User Interface

Liquid Source Misted Chemical Deposition Module

The LSMCD Process Module deposits a uniform film of liquid sourced chemical onto the wafer surface.

- Reduces chemical usage by up to 50% (compared with spin-on technology)
- Can increase process yields by more than 50% (when compared with spin-on technology)
- Highly uniform, conformal film depositions
- Produces excellent results with MOD precursors
- The Auto Clean function quickly cleans the reactor periodically with no disassembly required
- In situ Edge Removal cleans deposited film from the wafer's edge

Rapid Thermal Annealing (RTA) Module

This multi-function module performs high temperature oxygen-based preclean, low temperature solvent boil-off and decomposition step, and final high temperature processing step to create a low-defect film with excellent ferroelectric properties (patent pending).

- Rapid, uniform, recipe controlled thermal processing up to 800 °C
- Vacuum capable, Oxygen or inert gas environment
- Thermal ramp rates up to 80 °C/sec with 60,000 watts peak power
- Accurate, repeatable, closed-loop temperature control
- Fully adjustable radial temperature distribution accommodates different substrate materials

Automated Solvent Dispense System (Optional)

The fully integrated Solvent Dispense Cabinet safely delivers solvent to the LSMCD reactors for both edge removal and automatic reactor cleaning functions.

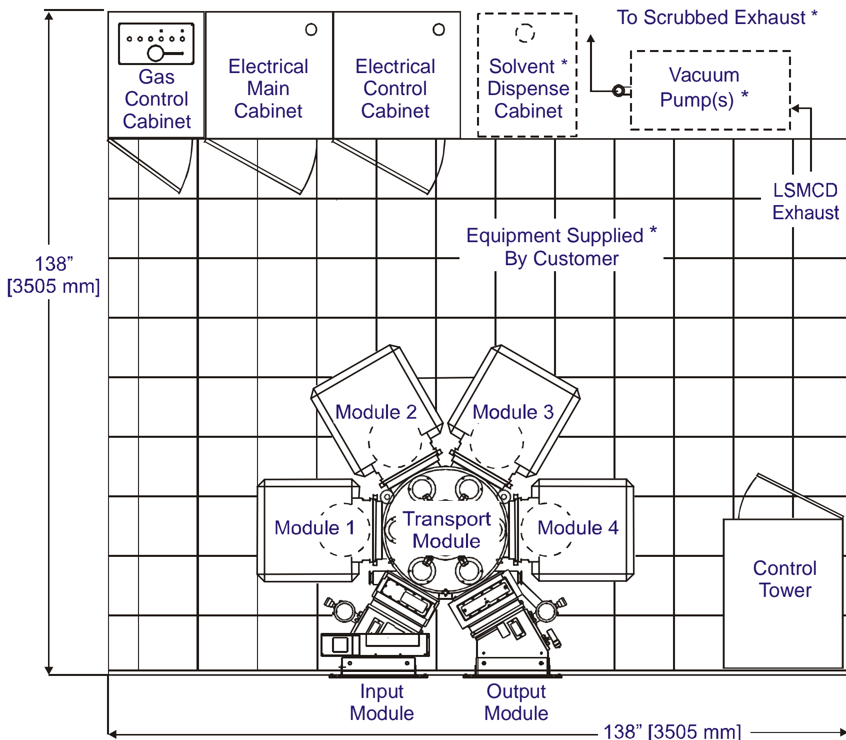
Specifications

6 Position LSMCD Cluster System

- LSMCD and RTA Module(s) to meet specific application and throughput requirements
- Input/Output Modules - 25-wafer Cassette Elevator
- Control Module
- Wafer Transport Chamber- 6-position, with high reliability robot
- Wafer Aligner
- Wafer Cooler
- Electrical Cabinets
- Gas/Liquid Control Cabinet

Overall Toolset

Power:	208 VAC, 40 A per LSMCD module 480 VAC, 100 A per RTA module
Air/Pneumatics:	80 PSI Air or Nitrogen at 1 lpm
Extraction:	400 CFM gas cabinet, 30 CFM solvent dispense cabinet
Process Gases:	Argon, Nitrogen, Oxygen regulated 0 - 100 PSI
Water Cooling:	8 lpm pump, 2 lpm reactor chilled water
Environment:	Standard Cleanroom
Input Capacity:	150 and 200 mm wafers (300 mm optional)
Throughput:	6 - 10 wafers per hour per reactor (typical)



LSMCD Module

Uniformity:	± 5% thickness ± 5% run-to-run
Conformality:	Conformal up to 70% on 0.5 micron deep features with 80° slope
Deposition Rate:	Up to 80 Å/minute
Particles Added:	0.17/cm^2 at 0.3 micron per wafer pass
Reactor Auto Clean:	7 - 10 minutes (typical)
Deposition Pressure:	600 - 760 torr (typical)
Chemical Usage:	MOD liquid flow < 0.25 sccm (typical)
Process Gases:	Nitrogen
Deposition Process:	Complex Metal Oxide MOD
Film Type:	Single precursor (two precursor graded film hardware optional)
In-situ Features:	Auto Clean, Wafer Edge Removal
Extraction:	30 CFM per module, house exhaust
Vacuum:	40 CFM dry mechanical pump

Rapid Thermal Annealing (RTA) Module

Heating method:	IR lamps, ramped single zone
Rated IR lamp life:	2000 hours
Temperature:	Thermocouples; optical pyrometer, center/edge measurements
Temperature range:	150 - 800 °C
Accuracy:	± 2 °C
Stability:	± 1 °C
Maximum ramp rate:	140 °C/second
Minimum ramp rate:	10 °C/second
Gas/atmosphere:	Argon, Nitrogen, Oxygen
Extraction:	30 CFM per module, house exhaust

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Ref: LSMCD-1-10/2002