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HHV WORLD

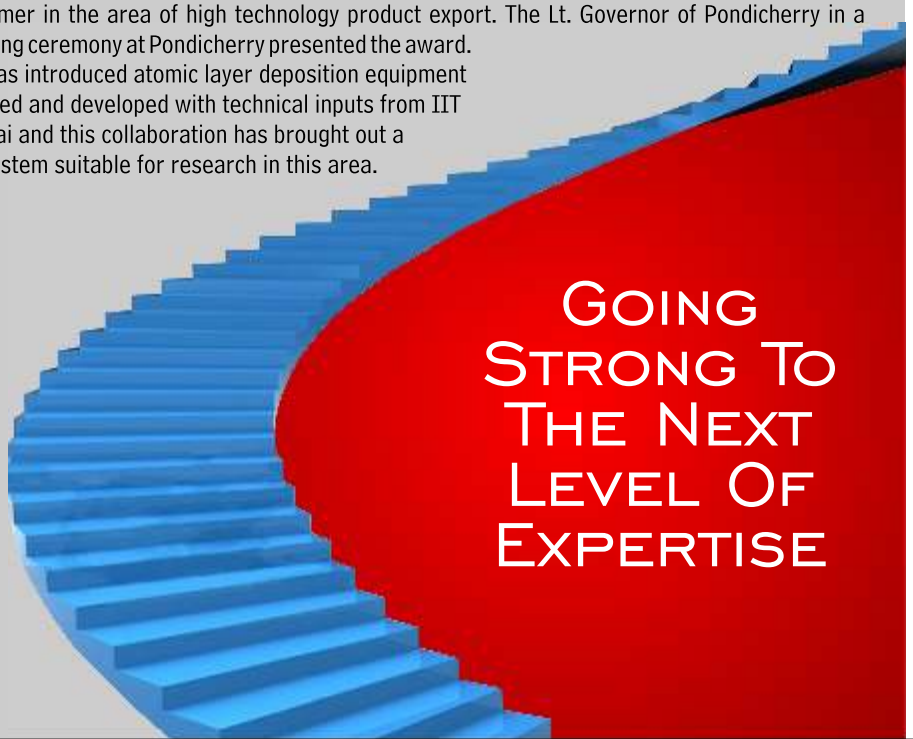
VACUUM EQUIPMENT • THIN FILM EQUIPMENT • OPTICS & THIN FILM COATINGS

HHV has had a long association with the Indian space program. It dates back to the early 1970's. HHV has supplied many equipment ranging from Thermovac systems to simulation to various facilities for manufacture of composites or special materials. One of the recent supplies has been the hypersonic wind tunnel facility where HHV has made a significant part of the total project. The project has been completed and established as a total facility by VSSC and regular Blow downs are taking place. The chairman of ISRO Dr. Kiran Kumar, dedicated this gigantic facility to the nation and on the occasion also honored HHV for the contribution.

Achieving space qualification for flight is no mean task and it requires the highest quality standards to be applicable in the manufacturing process with repeatability and precision. HHV has achieved the same for supply of MIC components used in hybrid microcircuits. Post the qualification HHV has also commenced regular supplies and is now establishing a lithography facility to further process the coated substrates.

HHV continues to get awards for its growth in exports and is again recognized by EEPC as a star performer in the area of high technology product export. The Lt. Governor of Pondicherry in a glittering ceremony at Pondicherry presented the award.

HHV has introduced atomic layer deposition equipment designed and developed with technical inputs from IIT Mumbai and this collaboration has brought out a ALD system suitable for research in this area.



GOING STRONG TO THE NEXT LEVEL OF EXPERTISE

INSIDE

Vacuum Arc Re-Melting furnace

The Vacuum ARC Re-melting (VAR) is intended to be used for melting / re-melting of reactive metals like
- **Titanium alloys**
- **NiTi shape memory alloys**
- **Niobium alloys and super alloys**
- **High strength steels, etc.**

VAR is also used to improve the cleanliness and refine the structure of standard air-melted or vacuum induction ingots.

HHV has designed and developed a high vacuum arc re-melting furnace for both
- Vacuum arc re-melting
- Vacuum arc skull melting in a tiltable water cooled crucible with pouring capacity of up to 500cc of liquid metal

The components / parts developed from the metals derived from VAR find applications in the field of aerospace structures, high temperature or aggressive chemical environments, electrical power plants, nuclear power plants, chemical and food industry, architectural, medical/biological applications, extreme sport applications, luxury goods, etc.

Features

The design of the VAR furnace includes state-of-art technologies for the various sub-systems and taking into account the safety issues arising from the operational experiences of other reactive metal melting furnaces.
- The double walled furnace chamber has a size of 300mm Diameter x 1000mm Cylindrical Height
- The specially designed water cooled stinger rod mechanism is meant to hold consumable electrodes of diameter size 50mm, 80mm and 110mm
- A servo motor controlled feeding mechanism for electrode ram movement with automatic feedback loop
- It is integrated with a DC Arc power supply
- The skull melting copper water cooled crucible is tiltable and used to melt the metallic charge and pouring volume of upto 500cc of liquid metal
- Vacuum sub-system is equipped with oil diffusion vacuum pump based system to evacuate the chamber to the ultimate vacuum level of better than 1×10^{-5} mbar, and an operating level of vacuum 1×10^{-4} mbar
- Various copper crucible water cooling arrangements of 80mm, 110mm and 150mm attached to the hydraulic arrangement for easy loading and unloading arrangement
- State-of-the-art control instrumentation with Programmable Logic Control along with Industrial PC and SCADA software for complete automation and to achieve data acquisition

Vacuum arc melting process is a very economical and low energy process in product homogeneity and quality.
A wide variety of alloys can be melted successively in the same crucible with no fear of chemical cross contamination.

Special Purpose High Vacuum Equipment For Leak Testing

HHV has designed, manufactured, and commissioned very large size special purpose high vacuum equipment used for helium leak testing by evacuating the cavities of the article to be tested.

Features

- Very large cylindrical chamber of 1750 mm diameter x 11000 mm cylindrical length with dished ends made out of SS316L
- Internal surface of the chamber has a finish of 1.6 micron to minimize leakage & out-gassing rates
- Battery operated article trolley of around 9 meter in length and a load capacity of 4.0 ton for precise movement of article into the chamber
- Specially designed article cradle with a load capacity of 3.0 ton and length of 4.0 meter
- Turbo based vacuum system along with rotary-roots combination which is specially used to evacuate the chamber and article to achieve a vacuum level of $5x10^{-5}$ mbar in about 30 minutes.
- The complete vacuum system is mounted on a skid.
- A specially designed pressurization and de-pressurization system for pressurization of the article and chamber as per the process requirement for carrying out the leak testing and also controlled depressurization of article and chamber
- State-of-the-art control instrumentation with Programmable Logic Control along with Industrial PC and SCADA software for complete automation and to achieve the process requirement.

Cathodic Arc Plasma Deposition

Cathodic arc deposition process is based on low-voltage, highcurrent arcs that produces dense, highly ionized plasma. It works under a range of low to high vacuum conditions using specially designed deposition heads. Cathodic arc deposition can be operated in either DC or pulsed modes. In either case, a power supply applies relatively low voltage which produces an arc discharge on cathode surface. The arc is concentrated over a small surface area on the cathode which forms a cathode spot. This spot moves randomly all over the cathode surface and the cathode material will gets eroded come out at a high rate from the cathode surface. The high current density associated with the cathode spots produces a localized phase transformation of the solid target (the cathode material) to almost fully ionized deposition plasma. The plasma expands rapidly into the ambient vacuum towards the substrate where the films are deposited.

The Cathodic arc deposition process has become the technology of choice for hard, wear resistant coatings on cutting and forming tools, corrosion resistant and decorative coatings on imitation jewellery, watch components, cutleries, kitchen & bathroom faucets, shower heads, door knobs, ceramic tiles, etc., and preparation of super hard films like Al2O3& a-DLC,and many other applications.

There are a number of advantages of the higher ion energies associated with cathodic arc deposition. For example, cathodic arc deposited films tend to be denser and have better adhesion characteristics than films produced using other methods. The deposited atoms penetrate the surface, locking the coating to the surface with high adhesion. By biasing the substrate, the impact energy of the ions on the substrate can be further increased. The energetic ions created by cathodic Arc Deposition also allow the use of lower substrate temperatures compared to other processes. This is because the Cathodic Arc Deposition ions carry sufficient energy to form dense, compact films without the need for additional thermal energy to be provided by the substrate.

Though, there are various advantages, the large stream of particles coming out of the target leads to a high roughness on the substrate, and the films are normally formed with compressive stress. The “macro-particle” problem has prevented the cathodic arc plasma deposition from being used in high technology applications. But incorporation of certain gadgets like magnetic field induced particle filtering can enhance the application of this technology perhaps to levels better than that of magnetron technology.

ARC Coat 1000 System

HHV has developed the ARC Coat 1000 system which is a customized production tool ideally suitable for industrial environments. The system is equipped with 6 numbers of 3 inch ARC sources with dedicated power supplies. The planetary work holder holds any shape and sizes of the jobs to be coated. The PLC control system provides precise process monitor with user friendly operating interface terminal for easy man-machine communications.

Features: Suitable for functional and decorative coatings, High deposition rate, High end repeatability, Good flexibility, Low maintenance and high through put, Multiple ARC sources with dedicated power supplies, Semi automation, can be customized as per the production requirement and throughput.

Cathodic arc with plasma

Applications:

The HHV ARC Coat 1000 system can be used to deposit;

Metal Films: : Titanium, Nickel, Chromium, Copper, etc.

Compound Films : Titanium Nitride, Titanium Carbide, Zirconium Nitride, Chromium Nitride, etc.

Alloy Films: : Titanium-Carbo Nitride, Titanium-Aluminum Nitride, Chromium-Aluminum Nitride, Titanium-Aluminum-Chromium Nitride, Titanium-Zirconium Nitride, etc.

It can be used for decorative coatings on imitation jewellery, watch components, cutleries, kitchen & bathroom faucets, shower heads, door knobs, ceramic tiles, etc.

Typical applications of Cathodic ARC deposition

HHV has delivered a state of art dual chamber sputter coater for producing special high performance coatings needed for satellite & space applications. The system is configured for two separate cylindrical chambers to carry out metallic sputtering in one chamber and reactive sputtering of oxides and nitrides in the other chamber. Both the chambers are connected with a common load lock facility to avoid exposure of the product to atmosphere during multilayer deposition of metals, oxides and nitrides. This load lock also facilitates automatic loading and unloading of the substrates during the processing

Thin Film Coatings For Advanced Space Applications

The whole system is mounted on a single frame along with an electrical and electronic enclosure. The system is also designed for field up gradation and to add additional chambers.

Both the chambers can be used independently or simultaneously at a time for the film deposition process. In any single chamber at least two sputter sources can be operated at a time for compound material deposition. Film thickness uniformity $< \pm 5\%$ can be achieved over a 150mm diameter wafer.

The ultimate base pressure of lower than $1 X10^{-7}$ mBar can be achieved in the individual chambers after the high vacuum valve is opened and initially back filled with dry nitrogen.

Process chamber for metallic sputtering

Chamber is provided with 2 Nos. of large viewports for viewing ofthe process and sample holder. A Vacuum pumping port is provided at the back side of the chamber to connect the turbo molecular pump

The 'O' ring sealed Chamber top plate provides for connecting three 3" dia. magnetrons in a sputter down configuration for deposition of metals along with one ion gun source for in-situ cleaning of the substrate.

3 No's of water cooled flex type balanced magnetron sources of 3 inch dia compatible with both RF/DC power supply are provided. Magnetron can accept target materials of 2mm to 10 mm thick.

Process chamber for oxide sputtering

The chambers are identical as the metallic sputter chamber except that it has a provision for more gases to be connected to the chamber through mass flow controllers.

Both the chambers have been provided with water-cooling and the special work holders can be cooled in-situ. The machine also has a facility to swap the coating process from a top down to a bottom up coating. The machine has the latest state of art software which allows for total automation as well as extensive data capture.

Dry Vacuum Pump (DP300/DP300 System)

Chemical/Pharma sector is one of the fastest growing sectors today in the Indian economy. The fast paced growth in these sectors and the flourishing replacement market for vacuum pumps initiated the concept of designing a special purpose chemical dry vacuum pump. With over five decades of experience in designing mainly rotary vane and roots boosters, the latest chemical dry vacuum pump was a paradigm shift for our team. The design concept of the pump is based on oil-free, non-contacting, four stage hook and claw mechanism. It provides consistent vacuum at high efficiencies, lowest cost of ownership with adequate safety and performance standards. Its vertical configuration system suits more for pharmaceutical and chemical applications.

The new pump is of 300m3/h capacity with an ultimate vacuum of less than 1mbar.

The Dry pump solution will help HHV customers replace steam ejectors and water ring vacuum pumps in the production lines which are known to create more effluent in the operations. HHV dry pump solution will ensure no effluent and it helps customers get a superior product

Combination Vacuum Pumping Systems/Solutions

HHV pumps combination units are made suitable to specific needs of customers and are unique and advanced solutions. These are superior to any other standard pump assemblies.

These combo units are designed for the highest safety standards and to achieve highly extracting performance parameters.

With over 200 combo units in the field HHV pumps is constantly evolving to be the leader in the industry.

Atomic Layer Deposition System

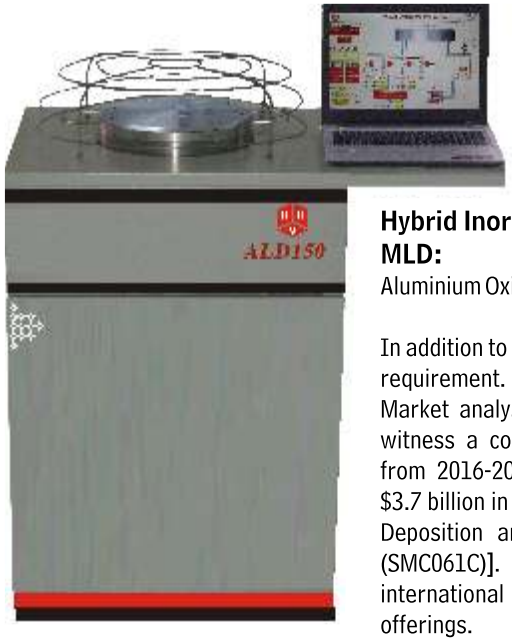
Atomic Layer Deposition (ALD) is a process technique that builds up thin film layers one monolayer at a time. The deposition technique gives great control over the thickness and the properties of the deposited films. Pin-hole free films can be deposited over large areas with extreme conformality, repeatability and precision.

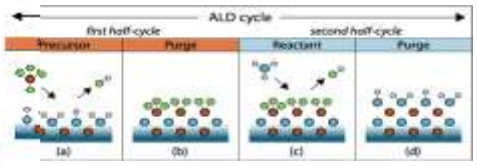
The films are built up by the exposure of the precursor materials to the substrate in a sequential manner. A continuous stream of purging gas ensures the removal of the excess precursors & other by-products from the chamber. A typical ALD deposition cycle starts with the introduction of the first precursor into the process chamber. The vapour pressure of the precursor, its residence time in the chamber, and the substrate temperature are adjusted so that a self limiting layer is chemisorbed onto the surface of the substrate. The excess precursor material and the by-products are then purged out of the chamber by the stream of inert gas. The second precursor material is then introduced into the chamber which reacts with the layer formed by the first precursor, thus completing the formation of a self-limiting compound layer. The excess precursors, and the by-products are again purged out by the inert gas. Under appropriate deposition conditions, each of this cycle of: 1. Introduction of reactant 1 (precursor A); 2. Purging; 3. Introduction of reactant 2 (precursor B); and 4.Purging, results in the formation of a monolayer of the deposited film onto the substrate.

HHV has developed the ALD150 tool based on the technology inputs from IIT Bombay with following features:

Features:

Mode	: Thermal
Substrate Size	: 6” diameter
Substrate Temperature	: 350 °C
Number of Precursors	: 2 precursor lines in basic version. Additional linescan be provided for higher versions
Vacuum System	: Oil Rotary Pump (or) Dry Scroll Pump with Vapour Trap
Interface	: Laptop
Automation	: NI LabView
Options	: Quartz Crystal Monitor, Scrubber





Hybrid Inorganic / Organic polymers through ALD / MLD:

Aluminium Oxide/Alucone, Zinc oxide/Zincone

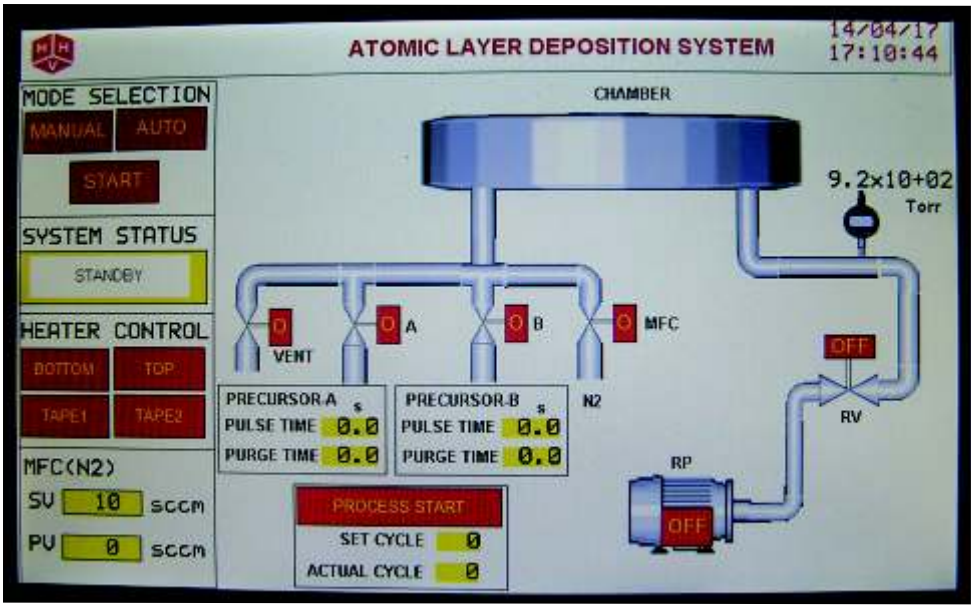
In addition to these, further recipes can be developed based on requirement.

Market analysis shows that the ALD technology is going to witness a compound annual growth rate (CAGR) of 19.1% from 2016-2021, leading to a global market size of almost $3.7 billion in the end year [BCC Research report Atomic Layer Deposition and other Ultrathin-Film Fabrication Processes (SMC061C)]. HHV is geared up to support the Indian and international research and businesses with its product offerings.

The ALD process finds applications in various areas such as electronics, optics, energy, life sciences, sensors, instrumentation, nanotechnology, medical, biological, mechanical, chemical, flexible devices, etc. In order to cater to the different segments, various recipes can be offered such as:

Inorganic Materials

Aluminium Oxide, Aluminium Sulphide, Zinc Oxide, Zinc Nitride, Indium Sulphide, Molybdenum Oxide, Molybdenum Nitride, Molybdenum Sulphide, Tungsten Oxide, Tungsten Nitride, Tungsten Disulfide, Nickel Sulphide, Cobalt Oxide, Antimony Sulphide, and Titanium Sulphide.



53rd Foundation Day Celebrations

Shri. S V Narasaiah - Chairman & Smt. Sarojini Devi - Founder Director along with Mr. Nagarjun Sakhamuri - Managing Director (Extreme left) and Mr. Prasanth Sakhamuri - Managing Director (Extreme right)

Shri. S V Narasaiah - Chairman, lighting the lamp in the presence of Mr. Nagarjun Sakhamuri - Managing Director and Mr. Prasanth Sakhamuri - Managing Director

Employees participation in the Foundation day

Employees participation in the Foundation day

With multiple reasons to cheer, HHV is going strong at its 53rd year of its establishment, with firm foot steps in the international market by show casing its engineering quality along with proven process in few areas of its range of products.

The 53rd Foundation day of HHV was celebrated at HHV on April 10, 2017 with great enthusiasm and active participation of all the employees.

Though, in HHV, it is a forum to review the previous performance and also to plan the future business, this year, it turned out to be the occasion of sharing new product developments, new infrastructure facility to produce high quality products, implementation of modern manufacturing practices in its various technology centre and technology development by its own R&D. There was a clear direction of future growth to be one of the best technology providers in the world through innovation and offering cost effective solutions in the field of vacuum technology.

The program ended with a pledge from one and all to work together and achieve the projected targets.

HHV at Global Expos

HHV at Indonesia:

Focused on "Heat treatment Furnaces and Metallization systems"

HHV participated in "Trade show worldwide 2017" at Indonesia focused on its **Latest Heat Treatment Furnaces For Metallurgical Process And Twin Door Metallization System For Automotive Industries**.

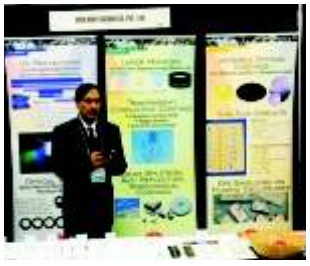
It was a big splash as an exhibitor. There was a good flow of business visitors from across the world to HHV stall. HHV is offering standard and customized vacuum furnaces.

HHV Managing Director Mr. Nagarjun Sakhamuri with the Indian Ambassador to Indonesia

HHV at San Francisco and San Diego, USA:

Focused on Thin Film Optical Coating Products

"Optics & Thin Film Coatings" one of the technology centres in HHV group, created a tremendous impression at the international exhibition "SPIE Photonics West - 2017", at San Fransisco, USA, and "SPIE Optics and Photonics exhibition" at San Diego USA. It focused on its range of THIN FILM OPTICAL COATINGS PRODUCTS for international business. The qualities of HHV optical products were well appreciated and there were several demands for its future business growth.



Mr. Nagaraj - AGM at the exhibition stall in San Francisco .

Mr. Ramakrishna - Business head at the Exhibition stall in San Diego with the visitors

HHV at Vacuum Expo, UK:

Focused on Thin Film Deposition Systems

HHV showcasing its range of thin film deposition systems at United Kingdom.

HHV Ltd, UK a UK based HHV group company, participated in "Photonics, UK-2017", "Vacuum Expo 2017" to demonstrate its internationally accepted range of "Thin Film Deposition Systems" for various applications ranging from R&D to mass production in industries.

Space Qualification for Metallized MIC Metallized Substrates

HHV Managing Director Mr. Prasanth Sakhamuri receives the certificate from Dr. A. K. Lal - Group Director SRC/SAC in the presence of Mr. N. J. Babu - Chief Operating Officer TFD, HHV, Mr. Ramakrishna - Senior Manager - TFD along with thin film technical team members of SAC.

Metallized microwave integrated circuit board

HHV has successfully completed development project with Space Applications Centre-Ahmedabad (part of ISRO) for Alumina metallization. The three layer metallization (Cr-Au) has undergone stringent spacequalification criteria and passed through all the tests to meet space worthiness. All the layers are deposited by using dedicated magnetron sputtering system manufactured in-house. The thin film coatings are being carried out in an ISO 7 clean room to maintain the stringent quality requirements by ISRO.

The components manufactured and supplied to SAC will be used in the satellites as part of RF communication assembly. HHV will also be doing forward integration by adding Photolithography facility to generate necessary patterns.

Excellent Track Record in executing large projects

HHV has an excellent track record in executing large on site projects in vacuum technology. This record was again reinforced with the completion of "Horton sphere system coupled to the wind tunnel" for Indian Space Research Organisation.

HHV Managing Director Mr. Nagarjun Sakhamuri being felicitated by ISRO Chairman Mr. A.S. Kiran Kumar, during commissioning of Hypersonic Wind Tunnel.

Star Performer: Large Enterprise award by EEPC India

HHV is a privileged awardee by EEPC India (Engineering Export Promotion Council) for its outstanding performance in the Southern Regional Export in the category of "Star Performer - Large Enterprise"

This recognition to HHV has been earned by the quality of products that have been exported and HHV receives the EEPC (Engineering Export Promotion Council) India award .

Mr. N J Babu - Chief Operating Officer of HHV receives the award from Lt. Gov of Puducherry, Mrs. Kiran Bedi.

Hind High Vacuum Co. (P) Ltd.
Site No.17, Phase 1, Peenya Industrial Area, Bangalore 560 058, India. Ph: +91 80 41931000.
Fax: +91 80 28394874. Email: info@hhv.in Web: www.hhv.in