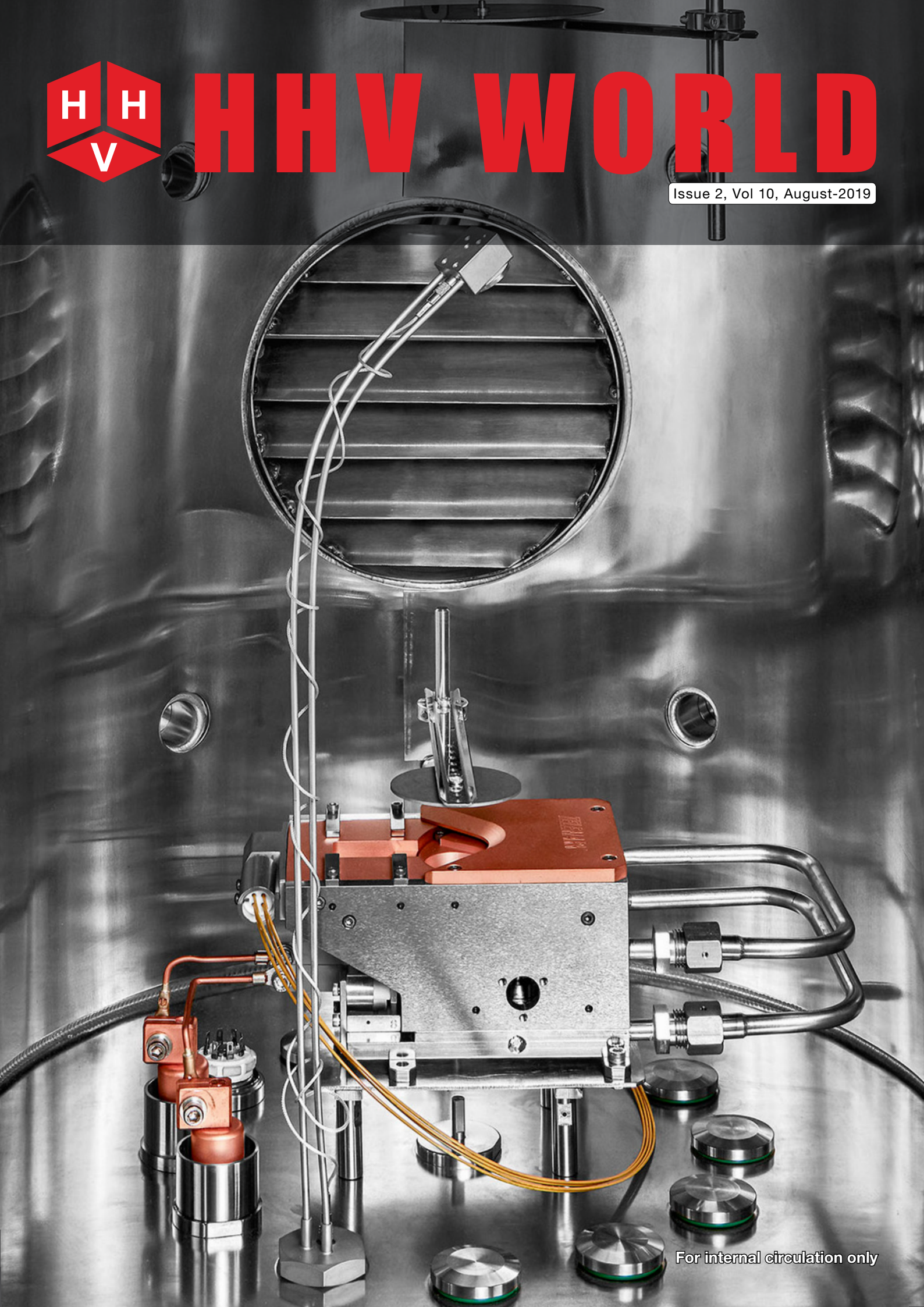
HHV WORLD

Issue 2, Vol 10, August-2019



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Editorial

Vacuum technology is the base for most cutting-edge technologies in the world.

HHV has been involved in development of specialized semi-production equipment for development of highly conductive transparent films which will find applications in heaters, flexible electronics, EMI shielding to name a few. These breakthroughs will make a significant change in the products of the future.

Similarly, HHV has been able to make significant progress in the manufacture of equipment to produce Carbon- Carbon composite materials. The capability includes development of specialized equipment for siliconization of carbon composite components so that they have the required wear resistance which comes with a strong Silicon Carbide layer. HHV has also plans to produce composite components for specialized aerospace applications.

Large volume production equipment leads to reduced operating costs and high repeatability. HHV's new TF 1400 large volume thin film coater has established the capability of HHV to produce world-class high-volume production systems. The totally automated systems reduce operator dependence and also provide for web-based diagnostics.

HHV continues its development work in the area of thin film hybrid micro circuit substrates and has developed 2-layer and 4-layer schemes for different applications. These developments make the whole Indian space program indigenization efforts a quicker reality. Efforts to optimize the production process and increase the output to meet the Indian Space programs growing needs continues to be HHV's challenge.

Components are the strength of any vacuum system and the need for a strong reliable platform of pipeline components continues to be a priority at HHV. The development of the slim line gate valves along with the crevice free right-angle pipeline valves will enhance the reliability and quality of vacuum systems. Development in the ion guns will ensure enhancement in the coating process.

On the business front HHV has expanded its supply reach into many new countries in the world and has been able to provide solutions to customers in USA, China, Vietnam, and the United Kingdom to name a few. Continuous improvement and development remain HHV's vision to propel its research and development programs.

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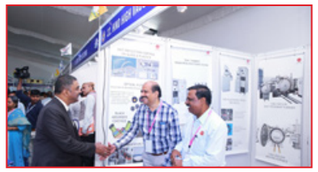

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Customized CVD, CVI, Graphitization & Siliconization furnaces for Producing Carbon-Carbon & Ceramic-Carbon Composite Materials

HHV has engineered and developed a range of customized high vacuum, high temperature CVD, CVI and Graphitization furnaces with robust hardware's and state of the art electronic-Computer control systems to operate the process tools for very long duration cycles lasting week to 10 days and these units are user friendly. These process tools are used for processing carbon-carbon and ceramic- carbon composites.

These furnaces are used to development and synthesising of composites such as Jet vanes, Exhaust throats, exhaust nozzles components, leading edge components for rockets such as booster engines, cryogenic engines, Re-entry vehicles such as PSLV,GSLV,RLV etc. These composites are high on Strength to weight ratio, very high temperature sustenance capability; special ceramic coated composites have high ablative and corrosive resistance at elevated operating temperatures.

CVD, DVI and Graphitization furnaces:

The CVD, CVI and Graphitization furnaces are used for production of carbon-carbon & ceramic-carbon composite articles with high temperature resistance coatings.

Siliconization furnaces:

Siliconization furnaces are used for impregnation of Liquid silicon in to Carbon-carbon composite articles to derive ceramic-Carbon articles such as SiC composites. SiC composites are high temperature resistant and also high abrasion resistant used in High temperature exhaust of combustion gas manipulation and management system for inertial guidance purpose and to sustain longer duration rocket engines operation to carry space pay loads in to higher altitudes.

Multi-purpose CVD, CVI furnaces:

The multi-pupose CVD, CVI furnaces are designed to deposit a range of materials such as SiC, BN, Si3N4, HfC, TaC, SiO2, Pyro Carbon, Pyro Graphite for applications at very high temperatures.

These carbon-carbon & ceramic-carbon composites with high temperature capability with hard ceramic coatings produced from CVD, CVI and 'siliconization furnaces have high strength, high temperature capability, ablative resistance at elevated temperature with low weights and are used in building space and aero-space launch vehicles and also used in certain satellite parts.

Pilot Inline Magnetron Sputtering System for Transparent Conductive Electrodes

A Model Pilot Scale System

HHV has been collaborating with various academic and research institutes across the country to continuously upgrade its technological capabilities. Recently HHV has entered into a research agreement with the Center for Nano and Soft Matter Sciences (CeNS), Bangalore to work on process machinery and technology for the fabrication of hybrid transparent conductive electrodes (TCEs). This joint activity was proposed to the Department of Science and Technology (DST) who has funded the program under the Nano Applications and Technology Development Programme (NATDP).

The initial phase of the project was to demonstrate the process technology on a 1 ft x 1 ft substrate. For this activity, an inline magnetron sputtering system was custom designed and fabricated to suit the specific requirements of the process. The system comprises of two process chambers with a common load lock chamber. One of the process chambers is designed for a sputter-up deposition, while the other chamber is designed for a sputter-down deposition. The positioning of magnetrons has been adjusted in both the process chambers to allow for substrate transport at the same level across all the three chambers. This design gives the flexibility to experiment with different possible orientations that will be suitable for the process. This design also offers the possibility to coat both sides of the substrate in the same run.

Each chamber is provided with individual turbo molecular pumps backed by a dry scroll pump to attain a base vacuum of better than 1 x 10^{-6} mbar. The system can accommodate a substrate of dimension 1ft × 1ft with a provision for being heated up to 400˚C in all the chambers.

The system is fitted with HHV make planar magnetrons of size ~ 525 mm x 120 mm with magnetic field configuration designed to give a high target utilization of ~ 50 %. A HHV inverted magnetron based linear ion gun is provided for substrate pre-cleaning and ion assistance during deposition.

The power supply is an advanced pulsing single magnetron sputtering power supply that sources both DC and pulsed DC. The power supply is designed for superior performance with features such as wide voltage range, low arc energy, flexible communication, and controllable output waveform.

The substrates are moved between the load-lock and process chambers on a conveyor system with adjustable speed which allows for additional tuning of the instantaneous deposition rates. Optical sensor based feedback is used for detecting the substrate position for automated transport. The chambers are provided with vacuum tight top lids which can be easily lifted with the aid of supporting gas springs. The overall thickness uniformity that can be achieved on a 1 ft x 1ft substrate is better than ± 5 %.

The complete system is controlled through a 15” IPC with SCADA software. A graphical user interface provides easy access to the various components and feedback of system parameters.

The system software allows for operation in fully automatic, manual and service (maintenance) mode. Recipes can be created for various processes and saved and retrieved for easy reproduction of process runs. The system has a modular design which allows for easy scale up with addition of more number of process chambers to increase the production rate.

The model of this system is ideally suited for proof-of-concept projects for scaling up technologies from the lab level to industrial level.

Thin Film Metallized Circuits for Space Applications

In 2017, HHV was awarded a 'Certification of Qualification' by the Space Application Center, ISRO for Thin Film Metalized substrates. Circuits are designed on these multi-layered metallized substrates and used in ISROs Space and Satellite program. This development led to HHV receiving the prestigious National Research and Development award for 2018.

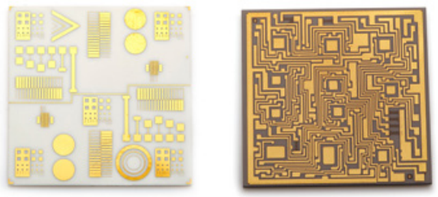
As a part of ISROs technology transfer program and as a forward integration of this technology, HHV has been selected to produce the entire Thin Film Metallized Circuit for ISRO's 40-micron accuracy line. HHV has begun producing these circuits in its new technology production line known as 'Photo Lithography'.

HHV has established a new Photo Lithography Lab (PLL) at its Dabaspet plant to develop TFMCs on alumina substrates that first need to be metallized in a vacuum chamber. Different circuits require different metallizations. HHV's PLL currently produces 3 types of circuits with 2-4 layers of metallization for different frequencies:

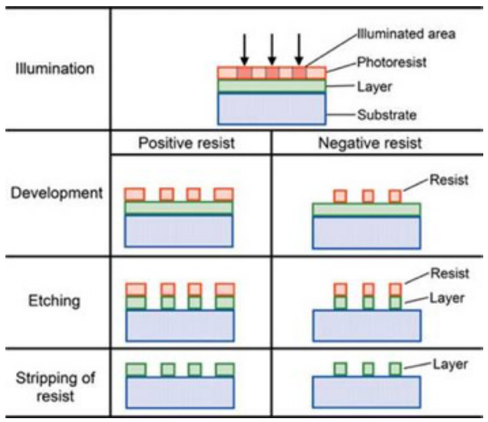
Chromium and Gold

Chromium, Copper and Gold

Chromium, Copper, Nickel and Gold



Once metallized these substrates are cleaned and then coated with a photo resistive material using a spin coater. A laser writer is used to define different designs as required by customers on blank chromium mask plates. Once covered with a patterned mask plate the substrates go through ultra-violet exposure to harden exposed areas. At HHV we use positive lithography to pattern and etch the metallized substrates.



Picture 1: Shows you how positive lithography takes place. The illuminated area is exposed to UV light.

A specialised etching room containing a chemical wet bench is used for multiple rounds of etching for each metallic layer. A dicing machine is then used to cut the metallized substrates to required sizes and an ISO 8 clean room is used to qualify the products. High performance microscopes and profile projectors are available for the inspection and measurement of the patterned substrates.

The entire process requires high levels of precision and sophisticated technology to deposit coatings, pattern the circuits and check the quality of the substrates within a 1000th of a millimetre.

All these processes require a clean room environment to ensure minimal interference with particle matter present in air. HHV's Photo Lithography Lab has ISO 7 and ISO 8 clean rooms as well as class 100 laminar flow stations that allow us to achieve resolutions of up to 40 microns.

As part of the 'Make in India' initiative HHV has been identified and qualified as the TFMC producer for ISRO's satellite program. Thin Film Metallized Circuits have multiple applications from satellites to defence to binoculars.

Plasma Enhanced Chemical Vapour Deposition System

Plasma-enhanced chemical vapour deposition (PECVD) is a tool to deposit thin films from a gas or vapour state to a solid state on to a substrate. Chemical reactions involved in the process occur by creation of a plasma of the reactant gases. The use of plasma substantially reduces the process temperature thereby making it possible to deposit on a wider range of substrates.

The plasma is created either by alternating current (AC) or direct current (DC) discharge and the plasma source can be coupled either capacitively or inductively. In case of capacitively coupled plasma discharges, the voltage is applied between two parallel electrodes, the space between which is filled with the reactant gases.

HHV offers flexible high performance PECVD tools for precise control of processes suitable for research and development in the areas of MEMS/NEMS, Solid State Lighting, Renewable Energy, Nano Electronics, Photonics, etc.

HHV has manufactured and commissioned a PECVD system built using single ingot aluminium machining for enhanced performance. The system comprises of one process chamber coupled with a load lock chamber arranged in line. The process chamber is fabricated with nominal internal dimensions of 400mm diameter and 194mm height and can accommodate up to 6” diameter substrates. The process chamber is designed for downward deposition with the showerhead on top and substrate at bottom. Substrate temperature can be varied from room temperature to 400° C during deposition with temperature controller. Both the load-lock and the process chambers are provided with individual turbo molecular pumps backed by dry scroll pumps. The TMP in the process chamber is corrosion resistant. The transfer of substrate between the load-lock and the substrate is done using an automated robotic arm. The load lock chamber is provided with an acrylic door for a complete view of the substrate and the transfer mechanism. The system operates with a RF (13.56 MHz) power source of 600 W capacity. A Low Frequency (LF) source with frequency variable between 100 – 450 kHz is also included to tune and minimize the stress in the deposited films. The pumps, vacuum assembly, power supplies, temperature controllers, etc. are all placed below the chamber, and the electrical switch gears are placed on the backside for easy access. A gas manifold comprising of eight gas lines with individual Mass Flow Controllers (MFCs) and bypass lines is attached to the backside of the panel making for a compact design.

The design of shower head ensures a uniform plasma distribution across the substrate with thickness variation < ±3 % over a 6” diameter substrate and also resulting in process variation < ±2 % in multiple runs. The thickness uniformity data mapped for Silicon Nitride and Silicon Oxide samples are given in figures 1 and 2, respectively

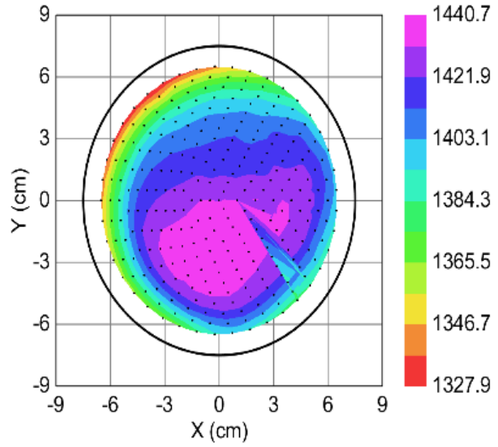


Fig 1. Thickness variation across a 6 inch silicon wafer (with 10 mm edge exclusion) for Silicon Nitride film

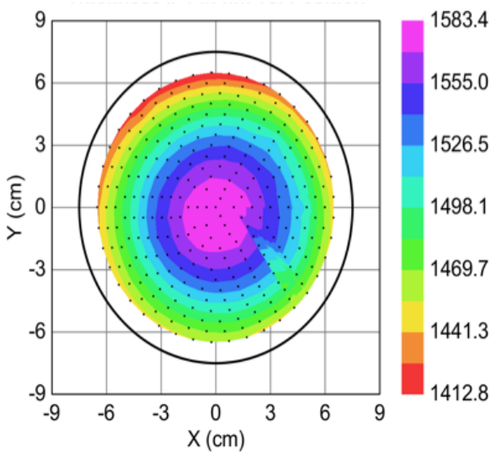
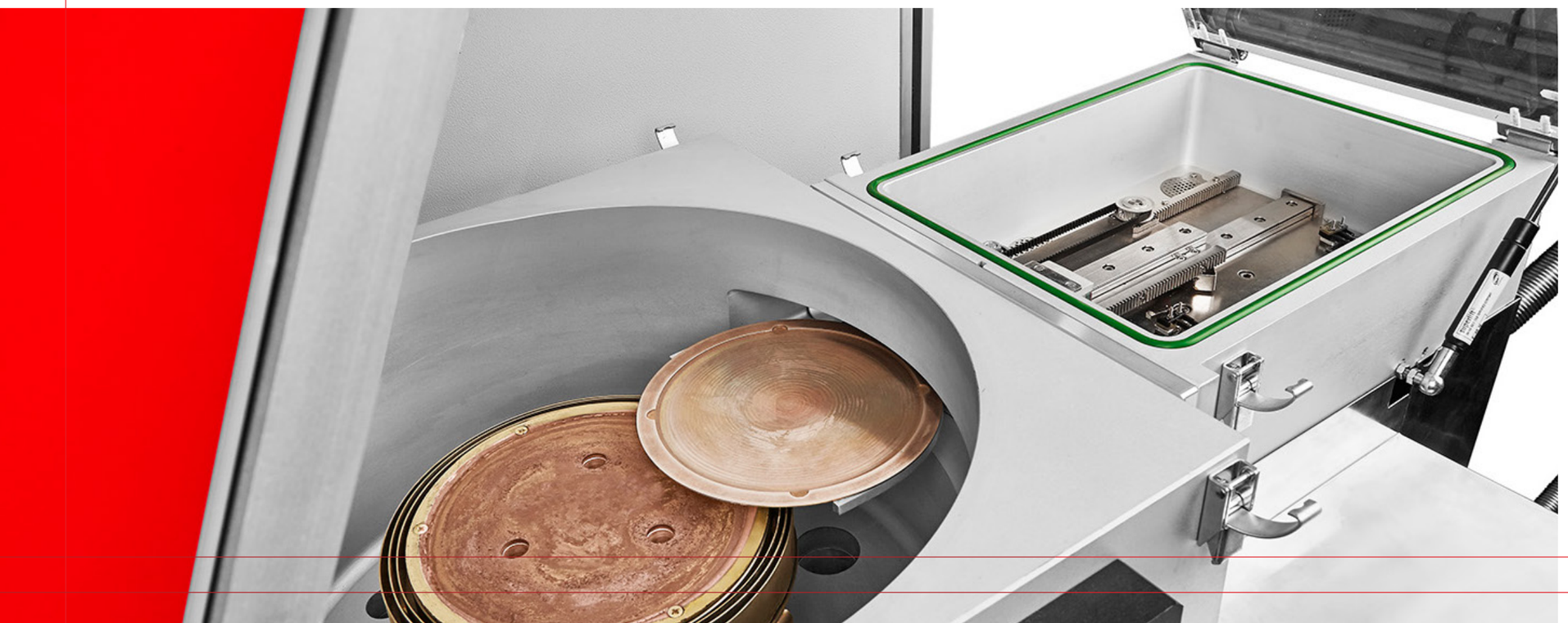


Fig 2. Thickness variation across a 6 inch silicon wafer (with 10 mm edge exclusion) for Silicon Oxide film



HHV has a rich expertise in development of PECVD tools for fabrication of amorphous silicon solar cells. Our R&D team has developed the process recipe for deposition of silicon oxide and silicon nitride in this deposition tool designed to meet a deposition rate > 100 Å/min for Si_3N_4 and > 300 Å/min for SiO_2 films. By tuning the RF and LF power sources, the stress levels in the films has been kept under 200 MPa for a 1 µm thick film. These recipes have been integrated into the system as part of the process library. Stress measurements were carried with K-Space MOS Laser based curvature measurement System. The stress in the film is calculated by measuring the bow (curvature) of wafer before and after deposition.

A recipe for in-situ cleaning using SF6 gas is also included as part of the system so that the frequency of maintenance of the process chamber can be minimized. This ability of HHV to develop and incorporate process recipes as part of its systems puts it in a different league amongst OEMs in the area of Vacuum coaters.

The entire process can be done in auto mode of operation, monitored and controlled from a PC loaded with the necessary SCADA (Supervisory Control and Data Acquisition) software. The software has the provision to create and save recipes corresponding to different processes. The SCADA software developed for the system allows flexibility to fine tune the critical process parameters, and at the same time offers a graphical user interface which enables user-friendly operation.

The SAARA PECVD system offers superior performance combined with a compact design at an affordable cost which can serve the requirements of both the research and industrial customers.

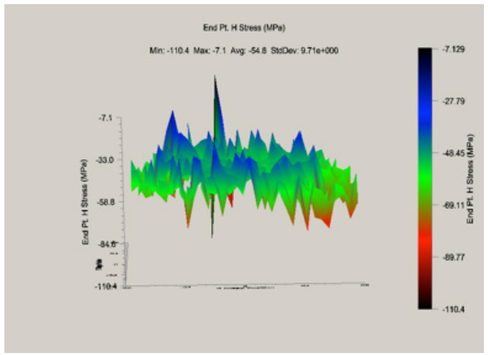


Fig 4. Stress measurement plot for Si3N4 film over 6 inch wafer

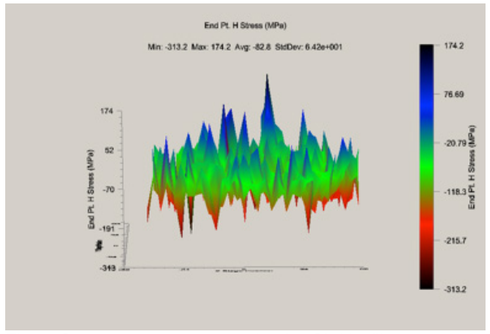


Fig 3. Stress measurement plot for Si3N4 film over 6 inch wafer

Thin Film Coating System for Mass Production – TF 1400

HHV has introduced for large volume production its state-of-the-art thin film deposition system - the TF 1400.

This high vacuum box coater is a versatile unit for large volume production with facilities for electron beam evaporation, thermal evaporation, ion assisted deposition, ion cleaning (bombardment) with accessories for substrate heating, rotation, film thickness controller etc.

Optional accessories increase the versatility of the unit making it suitable for a variety of applications including optical thin film deposition. The accessories also include integration of a optical monitoring system.

Box configuration of the vacuum chamber allows much wider space for installation of various accessories making the unit flexible to do multi-product production.

Several different accessories can be left installed without the need to dismantle and reconfigure the chamber. Increased size of the process chamber means more substrates can be loaded in both planetary or rotary jig configurations.

A high-speed diffusion pump based vacuum system is fully integrated with necessary piping and valves, all operated automatically, is for high gas throughput handling and to produce clean and high vacuum in chamber. The facility also includes a high capacity cryo chiller for fast pump down times and to minimize any possible back streaming.

The coater is provided with various pumping options based upon the need and expectations of the end user. Pumping options would include turbo molecular or cryo pumps including diffusion pumps while for the initial pump down based on production cycle time expectations large capacity roots and rotary pumps are used.

Segmented type work holder makes loading and unloading of substrates easy and fast. Substrate rotation mechanisms with heating facility completes process requirement.

The chamber wall and base are covered with liners which are easily removable for cleaning A provision for connecting a cryo baffle is provided for better cycle time.

The system is operated with a highly optimized HMI and PLC based configuration which is easy to work with and allows the operator to work in various modes auto, manual or semi auto, easily. The touch screen provides all parameters with the status of all interlocks which ensures repeatable and trouble-free performance.

Compact Stainless steel Right Angle Valves

HHV offers highly compact pneumatically operated bellow sealed Right Angle Valve of 25mm and 50mm in Stainless Steel suitable for high vacuum and ultra high vacuum applications.

There was need in the market to develop a valve which was compact and cost effective which could replace existing aluminium material based designs. Bellow sealing was required in the product for better performance and long life. There was a requirement for the valve to crevice free and no traped volumes.

The newly developed valves are used as an “in-line” chamber isolation valve. Right Angle Valves are leak tight to the sensitivity of 10^{-9} mbar lit/sec.

The valves are made of stainless steel and are vacuum brazed to avoid any crevice which would otherwise be present by conventional methods. This unique manufacturing process has been possible due to the state of art facilities at HHV where vacuum brazing at 1100 deg C is carried out to produce a perfect valve. This process enhances vacuum performance and is corrosion resistant while using hazardous gases.

The valves are open fully for high conductance and to prevent bellow contamination. A 304 stainless steel body eliminates sharp inside corners and improves conductance. The valves are electropolished for lower outgassing and better corrosion resistance.

A lower cost variant without bellow sealing is also available for less critical applications. The valve can be offered with KF or CF flange options.

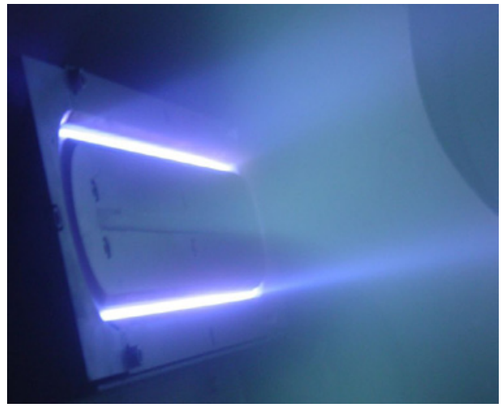
The welded bellows are made from AM-350 stainless steel to provide excellent corrosion resistance and flexibility. They are designed with additional segments to provide extended life.

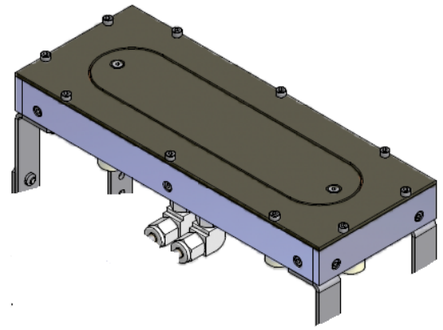
Features of HHV’s RPV include

- Full opening for improved conductance
- Electropolished body for low outgasing
- Edge welded bellows (optional)
- Crevice free
- UHV compatiable
- Bakeable upto 200deg C
- Compact size

Linear Ion Source

HHV has developed an inverted magnetron linear ion source, which can cover a substrate size of up to 300 mm. The operating range of the ion source is from 200 V to 3kV, with currents of the order of a few hundreds mA.





These ion sources are compatible with a wide variety of gases allowing materials to be processed in a reactive-gas environment. The ion source employs a water cooled copper anode, optimized magnetic field and a gas distribution mechanism for maintaining a uniform beam profile. The ion source can be operated in the diffused and collimated mode by varying the gas flow and voltage applied.

One of the biggest advantages of using this plasma source is in the area of coating on plastics. During the pre-cleaning process, the plasma jets generated impact the substrate to burn off hydrocarbons and activate the surface to promote adhesion of the deposited films. Very good adhesion of conductive coatings on plastic substrates has been successfully demonstrated by HHV using this ion source.

This ion source can be installed into various vacuum equipments such as optical coating equipment, In-line sputter coater, roll to roll sputter coater and cluster tool. The plasma source finds applications in various industry fields such as display, electronic device, new regeneration energy, automobile, steel industry and household appliances.

Applications

Pre-cleaning of glass and plastic substrates prior to thin film deposition.

Ion Assisted sputtering

Etch/Texturing of coatings

Plasma assisted chemical vapor deposition.

Laser world of Photonics 2018 Bangalore, India

HHV's Thin Films and Optics Division showcased its latest offerings at Laser World of Photonics at BIEC 26-28 Sept, 2018, Bangalore, India.

HHV's stall generated plenty of footfalls and received a large number of enquiries from interested domestic and international customers.

Heat Treat Show 2018 Mumbai, India

HHV participated in the HTS-2018, International Exhibition and Conference on Heat Treatment organized by ASM international at CIDCO Exhibition Centre, Navi Mumbai, India.The three days program was organized by ASM International-India Chapter on 27.09.2018.

Team HHV presented its range of products for Vacuum heat treatment , brazing, sintering, melting and other vacuum applications.

International Conference on Advanced Materials 2018 Trivandrum, India

HHV was a sponsor of the 3rd International Conference on Advanced Materials and Manufacturing Processes for strategic Sectors at Trivandrum, 2018.

The program was organized by The Indian Institute of Metals, Trivandrum Chapter from 25 – 27 October, 2018.

Team HHV showcased its range of products and projects designed and developed for space research and applications.

Dr Somnath S-Director VSSC, Dr V Narayanan-Director LPSC, Dr D Sam Dayala Dev-Director ISRO-ISU, Dr Vinay Kumar Dadhwal-Director IIST, Formar Director Mr Vishnu Kartha-Brahmos visited HHV stall,

ISRO, HAL, Midhani, Hindusthan Magnesium, GE, HC Strack, Indo-MIM, Starwire, Bayforge, Antrix Corp, Metalic Bellows, Bharat Forge etc. were amongst participants.

Label Expo 2018 New Delhi, India

HHV participated in Label Expo, held at the India Expo Center, from 22-25 Nov, 2018. HHV has showcased its range of thin films and optics products.

The qualities of HHV of HHV products are well appreciated and there is demand for its future business growth.

Bengaluru India Nano 2018, Bengaluru, India

HHV participated in the 10th Edition of Bangalore India Nano Conference and Exhibition held from the 5th to 7th of December 2018 in Bangalore. This annual event is organized by the Department of Information Technology, Biotechnology and Science & Technology, Government of Karnataka in association with Karnataka's Vision Group on Nanotechnology, chaired by Prof. C N R Rao, to foster a business environment for the development of Nanoscience and Nanotechnology Industry in India.

HHV launched its Atomic Layer Deposition system ALD-150 along with its Bench Top Coater at the event. The details of the various PVD and CVD based deposition tools manufactured by the Thin Film and Equipments division were displayed in the stall. Also, on display were the various optical and thin film components manufactured by the Thin Films and Optics Division . HHV's activities across its various divisions, namely the Systems Division, TFED and TFOD were presented as part of the Research Industry Collaboration Hub (RICH) session conducted as part of the conference.

The stall drew a lot of attention of the visitors from the academic and industry circuits. The stall won the Best Exhibitor Award for the Content and Information which was presented to the team by Prof. C N R Rao.

SPIE Photonics West 2019
San Francisco, USA

HHV participated in SPIE Photonics West – 2019 at San Francisco to demonstrate its globally accepted range of thin films and Optics products. It was well appreciated by the visitors and there were several demands for its future business growth.

HHV was the only Indian company to showcase this line of products at SPIE. We have been attending this exhibition annually from 2013.

International Conference for Small Satellites 2019
Hyderabad, India

The main aim and objective of this conference is to develop and commercialise small satellite systems. Small satellites are used to monitor the environments space weather and for space exploration. ISRO and DRDO are encouraging public and private institutions to develop small satellite systems.

This push for small satellites will lead to a requirement of space simulations chambers, thermo vacuum chambers. Members from IIT, Bombay, RV college, BITS Pilani, Veltech, Chennai DRDO are visited he HHV stall.

International Conference on Advanced Materials 2019
Kanpur, India

HHV participated in an international exhibition on an advanced Materials & Materials Technologies for prototype and systems (AMMTPS) held on 3 - 6 of April 2019 at DMSRDE, Kanpur . It has presented its technological strength to offer vacuum furnaces to develop advanced materials.

Indee Philippines 2019
Manila, Philippines

HHV showcased its range of vacuum technology based products in the international exhibition, Indee Philippines, 22-25 August 2018 at Manila. It displayed its capability to manufacture a range of vacuum furnaces for vacuum metallurgical applications

Spring Meeting 2019
Boston, USA

The HHV Ltd participated in Spring Meeting, Boston, USA in March 2019 organised by American Physical Society. It has displayed its range of thin film equipment for international business.

International Microscopy Congress 2018, Sydney, Australia

The HHV Ltd showcased its thin film equipment at International Microscopy Congress, September 2018, Sydney, Australia. It has demonstrated its bench top coater for international business.

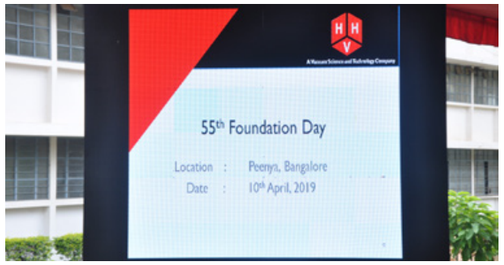
55th Foundation Day,
Bangalore, India

HHV celebrated its 55th foundation day on 10th April, 2019. The foundation day is jointly celebrated by the management and the employees.

The function started with the traditional lighting of the lamp and prayer. New products development of the previous year of each division was presented and was enthusiastically received.

Chairman Shri S V Narasaiah, Managing Directors - Mr. Nagarjun Sakhamuri, and Mr. Prasanth Sakhamuri in their speeches, indicated that the company is growing and with the encouragement of scientists, institutions, and the young team of employees guided by their respective seniors will become a leading global competitor in the field of vacuum science and technology.

The event ended with the distribution of awards to the best performers, long service employees in the company and with a high tea.



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