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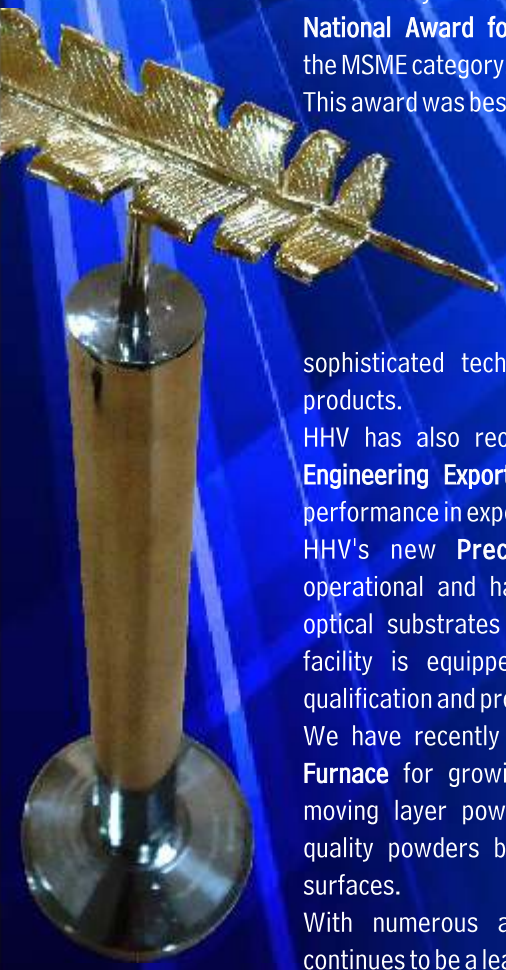
HHV WORLD

VACUUM SYSTEMS • THIN FILM EQUIPMENT • THIN FILMS & OPTICS



EDITORIAL

India's annual Technology Day takes place on May 11th, and this year HHV has been awarded the prestigious **National Award for Research and Development for 2018** in the MSME category.

This award was bestowed on HHV by considering the extensive development and research work carried out in its manufacture of Micro Integrated Circuit and Hybrid Micro Circuit substrates through magnetron sputtering. HHV has highly advanced magnetron sputtering technology which has allowed us to develop sophisticated technology to produce thin film circuits and products.

HHV has also received a **'Star Performer Award' from the Engineering Export Promotion Council (EEPC)** for its stellar performance in exporting high technology products.

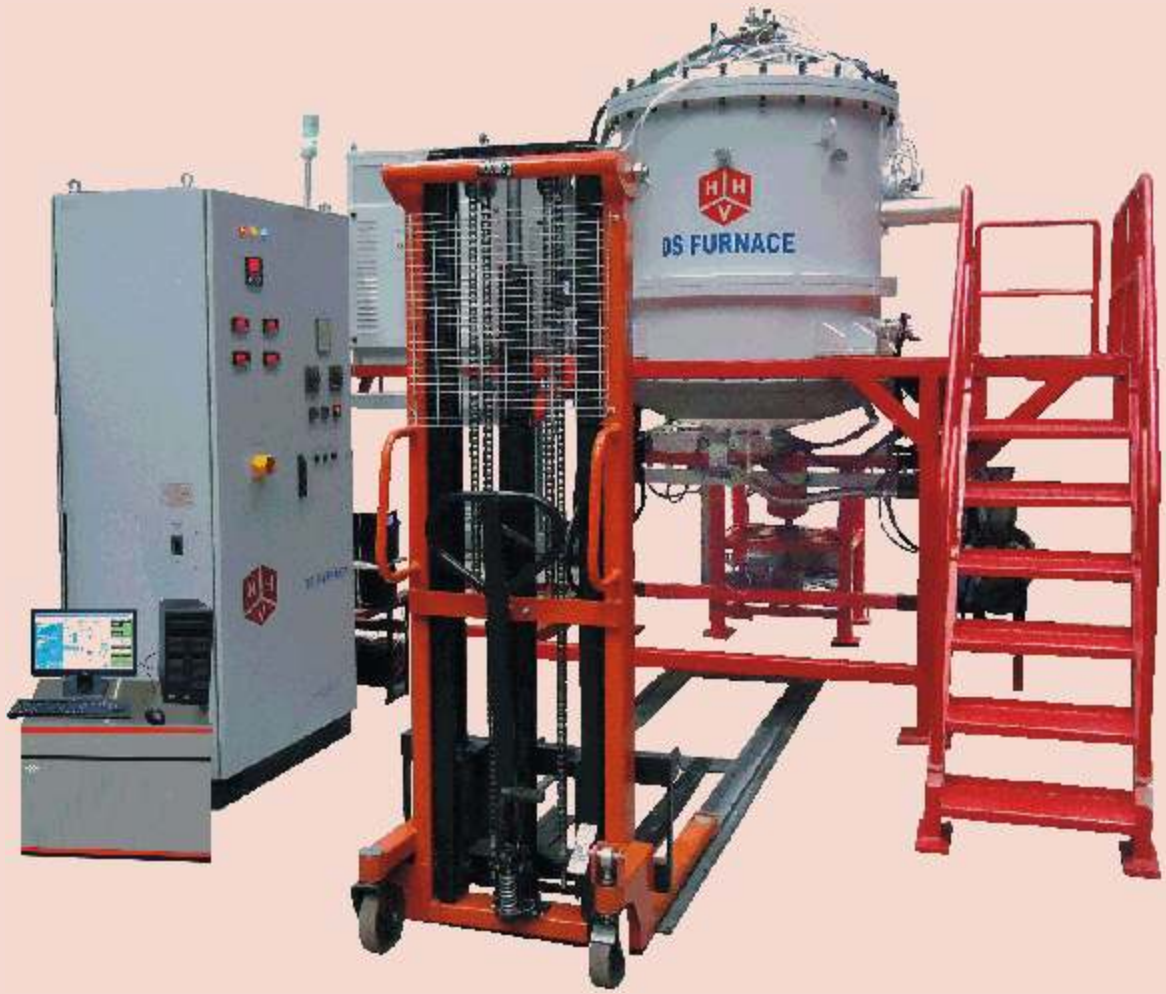
HHV's new **Precision Optical Fabrication Lab** is fully operational and has the capability to produce high quality optical substrates for visible and infrared light ranges. The facility is equipped with state of the art technology for qualification and production.

We have recently developed a new **Directional Solidification Furnace** for growing silicon ingots. The furnace includes a moving layer powder degassing system for producing high quality powders by removing absorbed gases from powder surfaces.

With numerous awards and technological advances HHV continues to be a leader in its field.

INSIDE

Directional Solidification Furnace for Crystallization of Silicon Ingots



HHV Directional Solidification Vacuum Furnaces (DSVF) are designed to produce high quality silicon ingots of 250 mm x 250 mm x 250 mm dimensions for high efficiency solar cells. The high pure silicon yield and the automatic operation cycle helps optimize the cost of producing silicon ingots.

The furnace can melt 20 Kgs of silicon feedstock at a time. The feedstock is loaded into a silicon crucible. The feedstock then crystallizes in a columnar fashion according to the Bridgman crystal growth process. The columnar growth of the crystals has been engineered for Photo-Voltaic (PV) applications.

Multi-crystalline silicon (mc-Si) grown by directional solidification has become the main solar cell material because of its low production cost. Today's multi-crystalline silicon is grown by the single-crucible heat exchange process, although the two-crucible casting method is also in use. The former is also referred to as directional solidification, given the importance that the controlled cooling and resulting direction of the crystals have on the properties of the material.

HHV DSVFs have chambers with a lifting facility that simplifies and secures loading and unloading operations. The optimized design and process ensures production of the required size and shape of the multi-crystalline silicon ingot.

A high performance vacuum system evacuates air from the furnace to achieve an ultimate vacuum of lower than $1x10^{-2}$ mbar in the furnace. The lateral and top pseudo-square heat zones have high precision heat controls and are highly insulated working areas to reduce melting time and electricity consumption.

The feedstock is charged in a silica crucible and is heated with graphite heat elements placed around the crucible until all the feedstock is completely melted by increasing the temperature to 1500 degrees Celsius. Graphite prevents heat loss and allows for the heat to transfer while cooling to produce ingot by opening the slit valve. This extraction of heat from the bottom of the crucible, by gradually opening the slit valve is done a well-defined programme in order to produce an ingot with required metal properties and crystal formation. While extracting the heat from the bottom of the crucible, the profile heat on the melted silicon feedstock is gradually reduced and results in the upward growth of the crystal. The criticality of the process is to programme the slit valve opening operation and the reduction of heat on the melted silicon to form the ingot in a cube without any cracks.

Moving Layer Powder Degassing Facility

Powder metallurgy is the process of converting metal powders into components. The components created are highly specialized with unique characteristics. This process gives the manufacturer control over the microstructure, porosity and machining operations, which is very difficult or impossible to do with conventional processing methods.

HHV has extensive experience in designing indigenous high vacuum equipment for this metallurgical process. To create a component from the metal powder, the powder is first compacted by introducing alloys in their elemental powdered form, then to enhance integrity and strength the compacted product is sintered, this sintered material is then characterized to produce the required component. The components produced are used in the space, defense, aerospace, and atomic energy fields. To improve the quality of the powdered metal a Moving Layer Powder Degassing machine with an electro-static separator was designed. The equipment removes absorbed gases from the powdered surfaces through degassing for high quality powders.

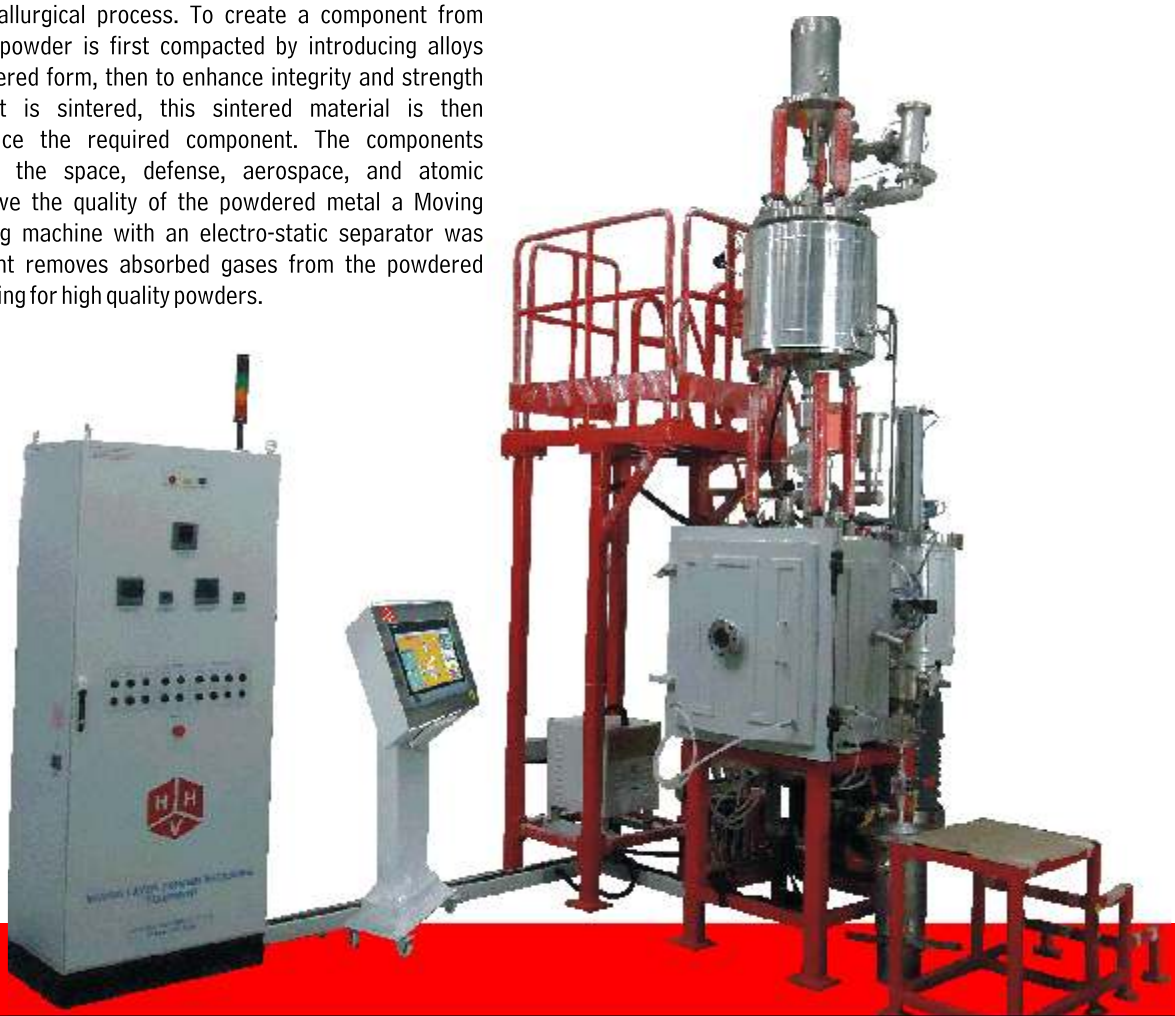
HHVs Moving Layer Powder Degassing (MLPD) machine has been designed with a capacity to handle 25.0 Kgs of powdered metal per batch under vacuum. It has two chambers:

1. A Pre- Degassing Chamber
2. A Main Degassing Chamber

The pre-degassing chamber receives the powder directly from the storage container which is placed at the top of the system. The powder is degassed at the vacuum level of 10^{-2} mbar at a temperature of 150°C in the pre-degassing chamber.

This pre-degassed powder is then transferred to the main degassing chamber which is at a higher vacuum than the first chamber. The powder is degassed again at 10-5 to 10-6 mbar at a temperature range of 400-500°C. The main chamber is equipped with electromagnetic vibrators that moves a thin layer of powder on a spiral track that is welded inside the chamber wall. The powder moves up the spiral track after being exposed to high vacuum temperature. Once degassed, the powder falls to the bottom of the main chamber. The process is repeated till the powder is degassed as required.

Finally, the degassed powder is transferred through a connecting tube into an evacuated metal capsule. The whole system is provided with the necessary vacuum, electrical, gas and water measuring and control systems with safety devices and interlocks. The level of degassing is monitored through a quadruple mass spectrometer that gives the user a quantitative dynamic analysis of residual gasses such as Argon, Nitrogen, Oxygen, water vapor, etc.



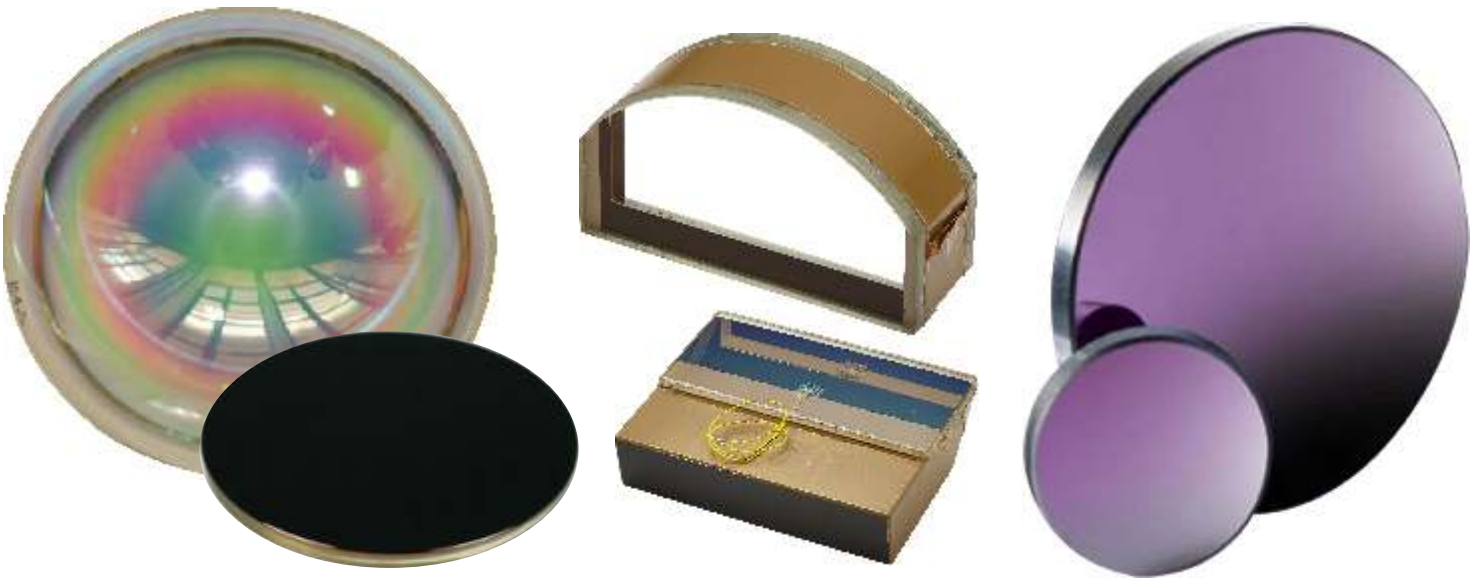
Precision Optics Fabrication Lab

Range of Lenses, Flats, Prisms and Domes for various applications

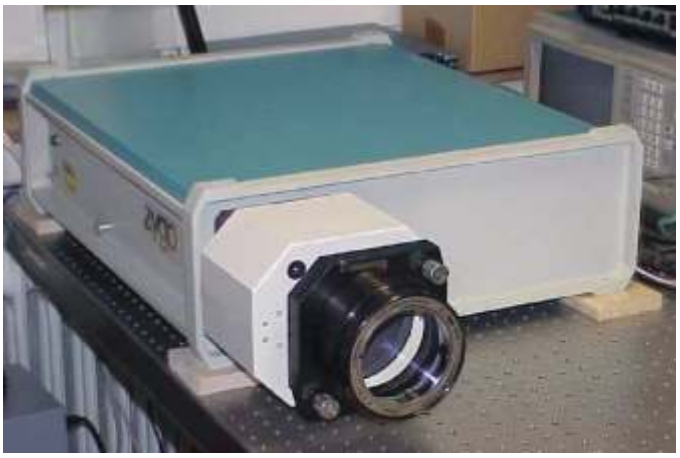
HHV has commissioned and inaugurated its new Precision Optics Fabrication Lab (OFL). It has been set up with state of the art technology and machinery to fabricate high precision optical components for the visible and infrared light ranges. With the addition of this lab, HHV offers end to end solutions, from substrate manufacture to the thin film coated component, for complex optical system requirements, especially for space and defense departments.

HHV's OFL is equipped with high quality machines for slitting, trepanning, curve generation, grinding, polishing, centering and edging for spherical and aspherical optics. Finished products go through rigorous quality checks with equipment such as Zygo interferometers with transmission spheres to measure surface figures to up to 1/10th of lambda, Davidson autocollimators to measure surface angles and parallelism to an accuracy of one arc second, and Trioptics spherometers to measure the radius of curvature of various components to an accuracy of one micron. HHV's expertise comes from its superior thin film coating ability and handling of materials like fused silica, zerodur, optical glass for the visible spectrum and silicon, germanium and zinc sulfide, barium fluoride, calcium fluoride and lithium fluoride materials for the infra-red spectrum.

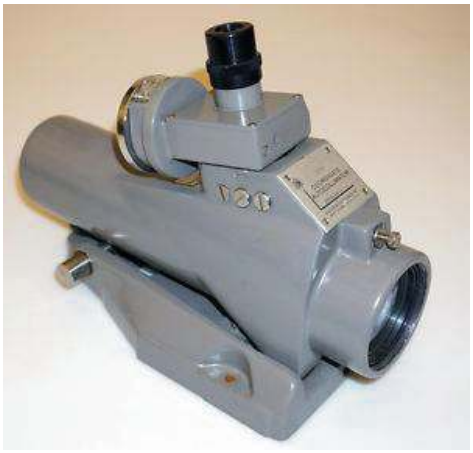
HHV's new OFL unit develops lenses, flats prisms and infra-red domes for applications including visible and night vision optics, binoculars, periscopes, astronomical telescopes and defense equipment. Clients include DRDO, ISRO and various ordinance factories



Optical Components

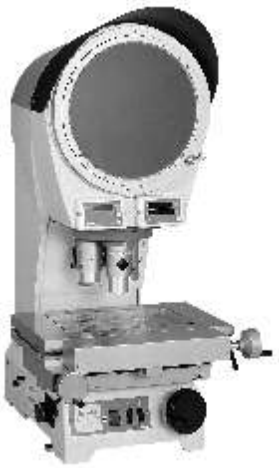


Interferometer



Autocollimator

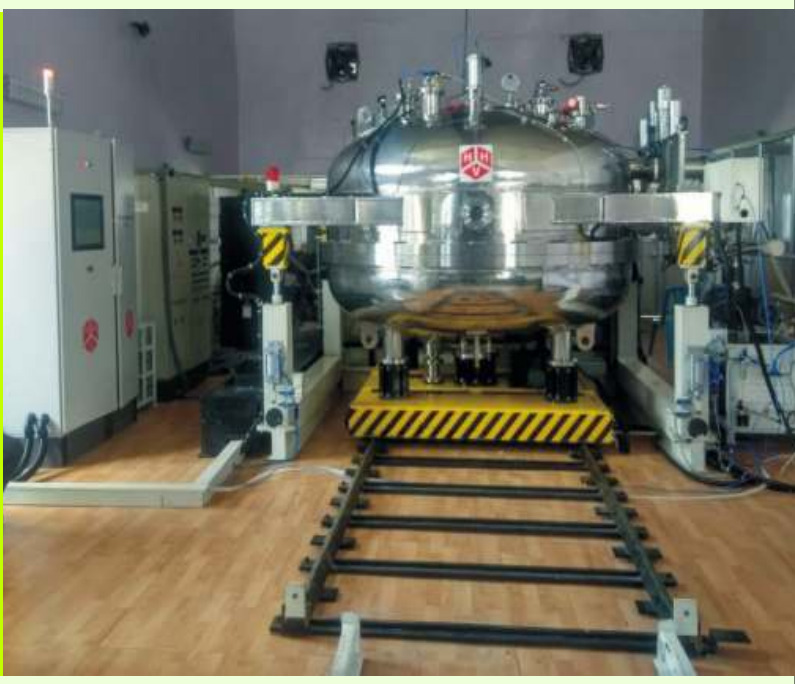
Spherometer



Nikon Profile Projector

Optical Fabrication Facility

Astronomical Telescope Mirror Coater



HHVs strength lies in its competency to design high quality equipment that offers tailor made solutions. Recently HHV received an order to manufacture an Astronomical Telescope Mirror Coater from the Indian Institute of Astrophysics (IIAP). It is the second order from IIAP and the fifth for HHV for astronomical applications.

The Telescope mirror coater has been developed using a customized design to accommodate the specified area to be coated and user friendly facilities to load, process and un-load the coated telescope mirrors.

The top portion of the chamber has a spherical dish that lifts and facilitates the movement of the bottom chamber to load the substrate into it. The top portion of the chamber is equipped with turbo pumps, high vacuum valves and gauges, feed through, a magnetron sputtering unit and an ion bombardment gun.

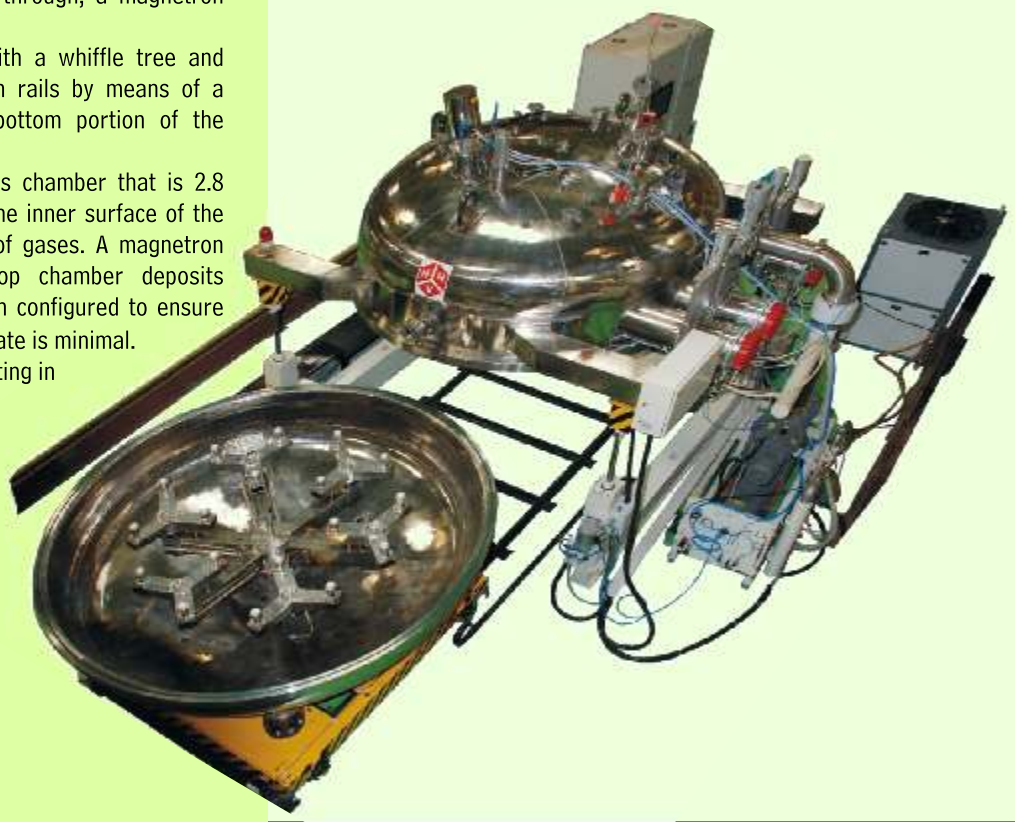
The bottom portion of the chamber comes with a whiffle tree and rotary drive mechanism and can be moved on rails by means of a motor drive mechanism which moves the bottom portion of the chamber to and fro.

The coating of the mirror is done in a process chamber that is 2.8 meters in diameter and 1.6 meters in height. The inner surface of the chamber is polished to minimize the trapping of gases. A magnetron sputtering source is mounted inside the top chamber deposits the film uniformly on the substrate. It has been configured to ensure that the distance between the source and substrate is minimal. This enables a high degree of grain growth resulting in superior reflectance.

The ion cleaning system consists of sector type ion bombardment gadget to focus the glow discharge towards the mirror. The glow discharge cleaning enhances the adhesion of Aluminium on the mirror. A turbo pump based vacuum system evacuates the air in the chamber to a vacuum level of 1 x 10^{-6} mbar.

Development of Hybrid Transparent Conductive Electrodes

HHV entered into a research agreement with CeNS to jointly develop Hybrid Transparent Conductive Electrodes (Hybrid TCEs). HHV and CeNS are involved in designing and developing the equipment to fabricate hybrid metal nano-mesh and Hybrid TCEs of over one square foot in area. The research will also include developing a set of process parameters for multiple specifications to fabricate the TCEs. The developed substrates can be used in transparent heaters, de-foggers, electrodes for solar cells, thermo-chromic and electro-chromic windows and displays. HHV is keen to work with academic and research institutions to scale-up and commercialize technology.



Symposium: I-Acept, LPSC 2018 at Bangalore, India

HHV participated in the international symposium on Innovations and Advances in Chemical and Electrical Propulsion Technologies in April 2018, LPSC held at Bangalore. HHV's team showcased its range of products and projects designed and developed for space applications. Dr. K. Sivan, Chairman of ISRO visited the HHV Stall and was impressed with its indigenous technological contribution to Indian space programs.

Conference: ICONSAT, 2018 at Bangalore, India

HHV participated in the 8th biennial international conference on Nano Science and Technology (ICONSAT 2018) hosted by the Centre for Nano and Soft Matter Sciences (CeNS) during the 21st and the 23rd of March at the Indian institute of Science, Bangalore, India. HHV presented its capability in nano-technology and optics and thin film coatings. HHV also demonstrated its Atomic Layer Deposition System.

Conference: ICAER 2017 at Mumbai, India

HHV made a big splash as an exhibitor at the International Conference on Advances in Energy Research (ICAER) organized by IIT Bombay. HHV showcased its range of optics and thin film technology and demonstrated its Atomic Layer Deposition (ALD) process.

Exhibition: ASET 2018, LPSC at Trivandrum, India

HHV showcased its capabilities to produce equipment and components for the space industry at the international exhibition on the 'Future Direction of Propulsion - AseT 2018, LPSC' held at Trivandrum in May (11th - 12th). Picture: Dr. A.E. Muthnayagam, Founder Director LPSC, is in discussion with Mr. Nagarjun Sakhamuri - Managing Director at HHV exhibition stall.

Exhibition: SPIE Photonics 2018 at San Francisco, USA

HHV showcased is Thin Film and Optics coating abilities and components that the SPIE Photonics West 2018 exhibition in San Francisco, USA from the 30th of January to the 1st of February in 2018. It shows cased its range of products for international business.

Exhibition: ASM International 2017 at Ohio, USA

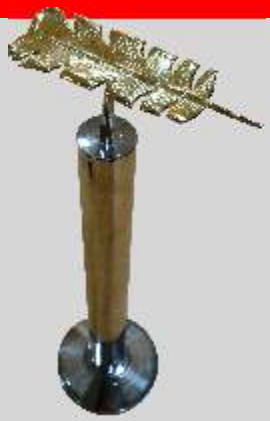
HHV participated in an international Exhibition, organized by the American Society of Metals. The heat treatment show was held at the Greater Columbus Convention Centre, Columbus, Ohio, USA from October 24th to the 26th, 2017. HHV displayed its capability to manufacture a range of vacuum furnaces for vacuum metallurgical applications.

Exhibition: ICOLD 2017 at Chennai, India

HHV participated in an international exhibition organized by the Indian Institute of Technology (IIT) Madras on 'Laser Deposition: Nanostructures, Hetero-structures and 2D layers (iCOLD- 2017)" in November 20th-22nd, 2017. HHV presented its technological strength in thin film technology and in particular the development of an Atomic Layer Deposition system.

54th Foundation Day

HHV celebrated its 54th foundation day on 18th April 2018. All personnel were in attendance. The function started with traditional lighting of lamp and a short prayer. New products developed by each division was shared. A brief history of the company was presented to recollect the milestones achieved at various stages by Chairman Shri S V Narasaiah. Managing Directors - Mr. Nagarjun Sakhamuri, and Mr. Prasanth Sakhamuri addressed the gathering. They encouraged all the employees to put in their best effort to become a leading global competitor in the field of vacuum science and technology. The function was concluded by the distribution of awards to the best performers followed by high tea.



National Award from the Government of India

In 2018, HHV has received the prestigious National Award for successful commercialization of indigenous technology in the MSME category. The award was conferred by the Technology Development Board, DST and Government of India. The award was received by Managing Director - Mr. Prasanth Sakhamuri and Assistant General Manager - S. Ramakrishna of HHV from the President of India, Shri Ram Nath Kovind at an award function held at Vigyan Bhavan, Delhi.

This outstanding product which is a '3- layer metallization on alumina substrate' better known as a Thin Film Metalized Circuit is used in high frequency RF circuits and was entirely developed by our dedicated team of R&D professionals at HHV's facility in Bengaluru. The award has placed us in a position to manufacture TFMCs for ISROs satellite program.

HHV a 'Star Performer' for Exports in the Southern Region

HHV has been selected as one of the Southern Region Export Award Winners for the year 2016-2017 by the Engineering Export Promotion Council (EEPC), a trade and investment promotional unit sponsored by the Ministry of Commerce and Industry, Government of India.

As an advisory body EEPC actively contributes to the export policies of the Government of India and acts as an interface between the engineering industry and the government. Set up in 1955, EEPC India now has a membership base of over 13,000 out of whom 60% are SMEs.

HHV has been deemed a 'Star Performer' in the Large Enterprise (Miscellaneous Instruments and Appliances) category. HHV has won this award three years in a row and is currently the largest exporter of UV reflectors for the printing industry worldwide. UV reflectors are also used for optical fiber manufacturing and coloring. Tribological coated components to measure viscosity were part of the extensive range of products exported by HHV in 2016-2017. HHV's other exports are high technology items such as diffusion pumps, thin film coating equipment and vacuum furnaces, which are exported to Australia, Europe, North America, the Middle East and South East Asia.

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