HHV WORLD

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Editorial

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

The diversity of the HHV group continues to bring new products and new technologies into the market at a constant pace to keep up with customer requirements.

Vacuum heat treatment continues to be an area of constant development to enhance the capability to quench materials at a very rapid rate is the need of the hour. Newer materials are being processed in 10Bar vacuum heat treatment and quenching furnaces for various advanced material processes.

The rotary brazing of the space craft divergent and convergent cones is a process which has been developed over many years. After supplying and installing two units, HHV is currently testing the largest rotary brazing furnace for the Indian Space programme at the Peenya facility. This new build at HHV shows that size is no constraint for vacuum brazing.

HHV Pumps have moved to a new state of art facility, which has additional space to enhance their capacity and bring out a new range of products specifically suitable for the Pharma industry.

Thin film coating applications continue to become popular. HHV is able to meet the needs of industry and research with the various range of products it provides ranging from twin door metallizers used in the automotive industry to complex atomic layer deposition systems which are now being used to deposit nano layers for various applications in photovoltaic, fuel cells, MEMS and sensors. HHV's robust ATS 500 can be used for research and production purposes. The ATS500 has been increasingly popular in the international and domestic markets.

HHV's optics facility produces over 100,000 optical components every year and is India's largest flat optics manufacturer. HHV has recently developed heated autoclaved prisms used in the defense industry for the domestic market. Heated prisms are suitable for periscopes used in armored personnel carriers, submarines and battle tanks. Cutting edge variants which can protect the viewer from laser damage have been developed as well.

HHV continues on its journey to develop and build high quality state of art equipment for diverse applications involving vacuum technology. HHV with its international reach through its wide network of highly trained and committed distributors is able to provide service and support to all its installations.

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Horizontal Vacuum Heat Treatment Furnace for Alloys

With the constant need in the metallurgical field to develop better materials which are both lighter and stronger, application of vacuum technology in the manufacturing process has been of paramount importance. Processes of melting, brazing, welding and casting by first creating vacuum and then backfilling with an inert gas in a chamber has helped produce better materials which have proved to be stronger, with thinner cross sections and with a long life due to prevention of oxidation and other contaminations.

This has brought about various requirements especially in the fields of space, aerospace, atomic energy, defence, medical, lighting, automotive, etc. The challenges involved in these high temperature, high vacuum and high pressure furnaces is that they have to be specifically designed and built with appropriate materials and pumping systems capable of ensuring a high level of vacuum integrity in spite of increased surface areas from various components and loads, in addition to appropriate heat shielding and insulation.

Heating is usually done by resistive heating. Depending upon the process, it can also be done by induction. Heating elements are made of Nichrome, Molybdenum, Tungsten, Tantalum or Graphite. Quenching is by gas (high pressure) or by dipping in oil. This requirement is also based upon materials and applications.

High pressure gas furnaces can go up to 20 bar. The ability to go to both sides of atmospheric pressure: vacuum and high pressure, requires specially designed seals that can ensure leak tightness at both lower and higher pressures.

Recently, HHV has designed and manufactured a 10 bar heat treatment furnace. It is a horizontal type, automated, high vacuum ($1x10^{-5}$ mbar) heat treatment furnace. The horizontal vacuum furnace with gas quenching facility can be used for heat treatment processes such as annealing, hardening, tempering and stress relieving. The vacuum furnace has been designed as per the ASME boiler and pressure vessel codes.

It has a chamber with a cylindrical length of 3500 mm and inner diameter of 1770 mm. The furnace chamber accommodates a hot zone of size 600 mm (W) x 600 mm (H) x 900 mm (D). Resistance heating is by graphite heating elements. The vacuum furnace has been designed for an operating temperature of 1300 °C, which can be attained within 120 minutes from room temperature with a full charge weight of 600 kg including jigs and fixtures. An internal finned tube type cross flow design heat exchanger allows cooling of the hot gas. The Gas Quench operation can be carried out upto 10 bar (absolute).

The totally automated heat treatment furnace has been provided with an auto-mode facility for operation with temperature controller, programmable logic controller, SCADA, measuring and control instrumentations, etc., for user friendly operation.

Rotary Vacuum Brazing Furnace

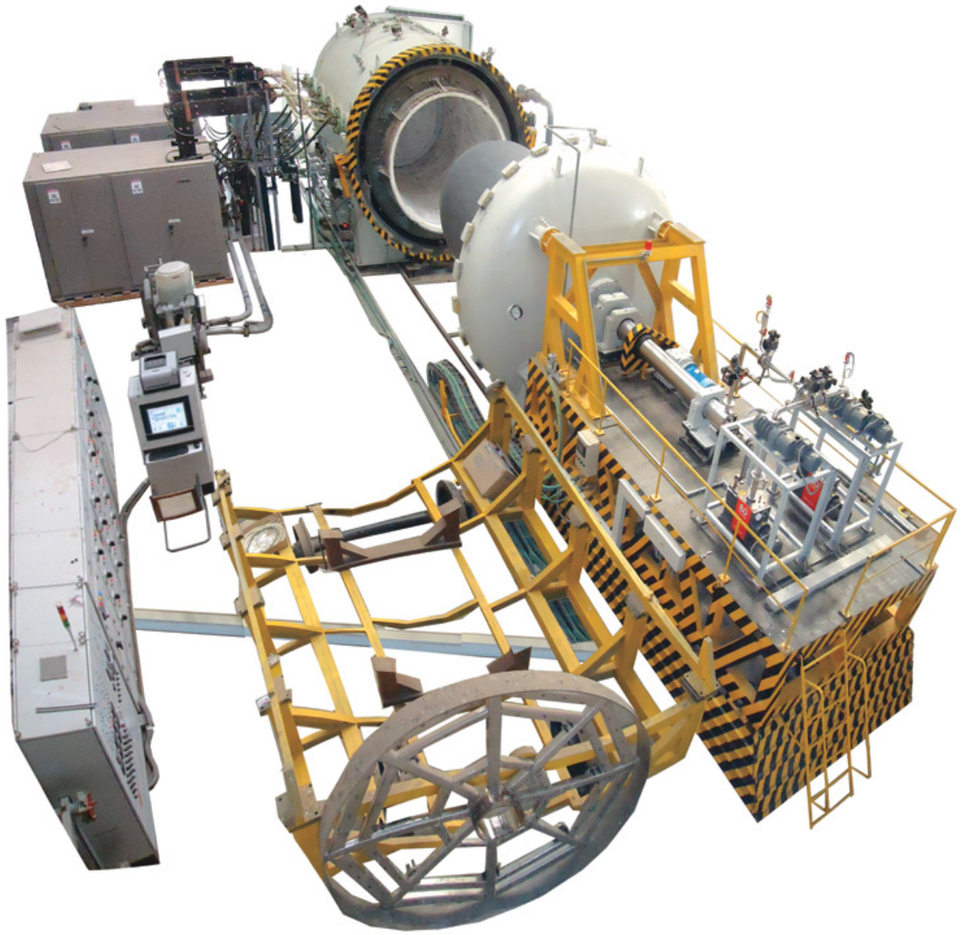
As an active partner to the Indian Space in designing, developing and supplying a range of sophisticated vacuum technology based equipment for different applications, HHV has been given an opportunity to build a technologically challenging automated rotary vacuum brazing furnace for ISRO's satellite launch vehicle programme for the second time.

Rotary vacuum/pressure brazing furnace is specially employed for brazing of two components of convergent and divergent cones made of specific super alloys used in cryogenic engine technology. These engines are used in launch vehicles to lift satellite packages to space for positioning at polar, geo synchronous and outer space engagements.

The role of launch vehicle engine is critical to ensure sucessfull lift-off of large payloads. The engine components are to be manufactured with high accuracy. Vacuum brazing of the engine's divergent and convergent cone is an important process to ensure its performance.

The two cylindrical portions have an annular gap of few millimeters and have internal guides to create a channel to circulate cryogenic liquid effectively and cool the engine at the same time. This is meant for circulating cryogenic fluid to cool the nozzle cones and hold its shape from burning off during firing of cryogenic engines during launch vehicle flight.

This brazing cannot be done with normal static vacuum brazing process. In stationary brazing, gravity will cause brazing material to fall off and leave certain areas un-brazed which causes failures. It requires a special type of brazing facility with the entire cylindrical components being rotated as the brazing process is on. The nozzle is held on a fixture to rotate the job inside.



As the component is rotated, the annular space between the nozzles is evacuated and pressure is applied on the external walls of the component while heating the component to a temperature of 1300 °C to ensure uniform brazing from all sides. Rotary vacuum cum pressure brazing ensures that the brazing materials remain in position and braze the two components with annular space perfectly in shape.

HHV had built the first rotary vacuum brazing furnace (RVBF) for MTAR, Hyderabad. The chamber size was 350 mm diameter and a cylindrical length of 450 mm with complete range of automation control and safety instrumentation. With the guidance of the space scientists and engineers, HHV was able to commission the RVBF, and successfully carry out the trails to braze small divergent and convergent nozzles.

This gave confidence to LPSC (Liquid Propulsion Systems Centre, ISRO) to place an order on HHV to build a large RVBFs for brazing of cryogenic engine components. HHV has successfully designed, developed, and commissioned the large rotary vacuum brazing furnace at M/S. Godrej – Mumbai on behalf of LPSC. HHV has demonstrated the RBVF brazing operations for the size of job of 2.0 m diameter x 2.6 m length. This achievement led to an another order from LPSC for supply of large Rotary vacuum brazing furnace.

With these two Rotary vacuum brazing furnace, ISRO-LPSC can cover the full spectrum of cryogenic engine sizes used at various stages of vehicle in PSLV, GSLV, and Mark III

This effort is challenging in all aspects including design, engineering and system automation, and the team at HHV has been able to successfully handle these challenges to deliver systems which are contributing at the back end to advance the country's space program.

Hybrid Twin Door System for Metallic Coatings

The automotive industry as a whole is being driven to manufacture cost-effective, environmentally friendly, light weight and more sophisticated automobiles. In this effort, one aspect is to replace metallic parts, such as lamp reflectors, grills, door handle covers and sills with less expensive light weight plastics, which are coated with a thin film of any desired reflective metal.

HHV is a leading supplier of state-of-the-art, high speed production capable, twin door vacuum metalizing systems for the automotive industry across the globe. These systems have been designed to deposit suitable material utilizing thermal evaporation or sputtering technique, on the automobile parts without distinction of shape, structure and size.

Recently, the company has also taken up a challenging task for a world leader in automobile parts, to manufacture hybrid vacuum metallizing machines which involve both thermal and sputtering technique. This enhances the quality, reliability, durability and results in dense and thick coatings, adding ruggedness to withstand all environmental conditions.

The system has been designed with a vertically mounted chamber of size 800 mm (ID) x 1580 mm (Ht). Substrates of surface size from 50 x 50 mm to 200 x 900 mm and depth from 2 to 100 mm can be accommodated.

The sputtering configuration has two numbers of high power, water cooled, rectangular magnetron sources to hold a metal target of size 173 mm (W) x 1392 mm (Ht) on either side. In thermal evaporation configuration the deposition source consists of tungsten filaments located on each door and connected to bus bars. Work holders of size 710 mm (Diameter) x 1220 mm (Ht), located one in each door, are made to rotate during metallization processes. Each work holder is designed to have a carrying capacity of 150 kg. The “harp” design of the evaporation bus bar provides better uniformity of the aluminium coatings and penetration on to the substrates.

Flexible and Fast System

This hybrid twin door metallizing system has a unique feature of user selectable configurations for specialised coatings for automobile reflectors. The system also has inbuilt process cycle parameters which can be selected as required and they are: (a) Plasma pre-treatment of substrates using process gases, (b) Plasma CVD pre-treatment of substrates using HMDSO (c) Sputtering / evaporation of Al and (d) Plasma CVD protective coating of substrates using HMDSO. The polymerization guarantees a protection of the substrate by preventing deterioration/corrosion.

The twin door mechanism reduces cycle times and hence increases productivity. An efficient pumping system has been provided which helps to enhance the productivity of the equipment.

The high vacuum system enables to achieve an ultimate vacuum of 10^{-5} mbar. It has been designed for batch production with cycle time of less than 4 minutes.

An HMI enables complete automation of process cycle. Necessary safety, alarms and control systems have been provided to ensure safety and ease of operation.

On the whole, the hybrid twin door metallization system is a robust unit that offers great flexibility, increased productivity and is user friendly which offers great value for money for automobile parts manufacturers. Vacuum technology is one of the best in terms of ensuring environmental compliance as the process happens in a controlled environment. The effluents are minimal and even so they are inert gases for most of the processes. This ensures that the manufacturing process leaves a lower footprint on the environment when it comes to an overall life cycle.

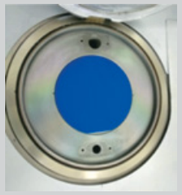
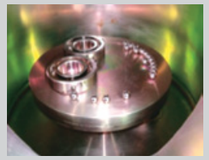
Atomic Layer Deposition Systems

Atomic layer deposition (ALD) is a thin-film deposition technique based on the sequential use of gaseous phase reactants typically called precursors. The precursors react with the surface of a material one at a time in a sequential, self-limiting, manner. Through the repeated cycles of exposure, a thin film is slowly deposited.

HHV ALD 150 standard model

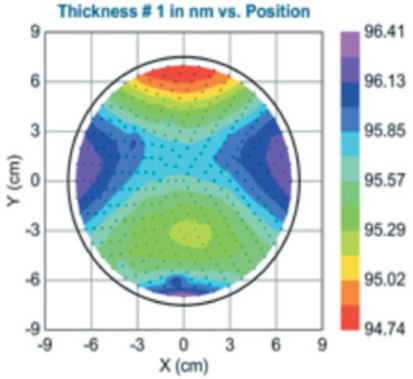
HHV ALD 150 with customized chamber

Component	Specification	
Activation Mode	Thermal	
Substrate Size	150 mm diameter	100 mm diameter
Substrate Temperature	Maximum 350 °C	Maximum 400 °C
Number of Precursors	2 precursor lines in basic version. Additional lines can be provided for higher versions with a maximum of 6 lines	
Vacuum System	Oil Rotary Pump (or) Dry Scroll Pump with Vapour Trap	
Valves	Heated precursor delivery valves	
Interface	Laptop	
Automation	NI LabView 	

Component	Specification	
Options	Quartz Crystal Monitor, Scrubber	
Features	• Capable of accommodating up to 6” diameter silicon wafer or other flat substrates • Small volume of 0.5 litres ensures fast purging of precursors between cycles • 2 ports, one for gas inlet, and other for pumping. 	• Capable of accommodating up to 4” diameter silicon wafer or other flat substrates, and suitable of holding 3-D objects that can be placed in this area • Shower-head design gives better coverage over 3-D objects • The top flange with shower-head can be swapped with ICP Source for future upgrade to Plasma ALD 

ALD is the only known technique which gives 100 percent conformal coverage and excellent thickness uniformity with pinhole free coating. The technique is highly scalable, and can be used to deposit a wide range of materials on different types of surfaces

HHV, for the first time in India has developed a commercial ALD system that produces films to an atomically specified thickness. ALD deposited films find application in a large number of areas such as solid state electronics, photovoltaics, fuel cells, batteries, protective coatings, optoelectronics, MEMS, memory devices, displays, flexible and wearable electronics, water purification, bioelectronics device, implantable device, sensors, etc.



Thickness map of Al2O3 thin film deposited on 6” diameter polished Si substrate

Recipes developed

Recipes have been developed for depositing metal oxide thin films such as Aluminium oxide, Zinc oxide and Titanium oxide by thermal ALD method using metal-organic precursors and H_2O as the oxidizing agent. Combinations of these materials are also possible to be deposited. Work is going on for developing recipes for Sulphides and Nitrides.

Other possible materials:

Inorganics:

Oxides: Molybdenum Oxide, Tungsten Oxide, Cobalt Oxide

Sulphides: Aluminium Sulphide, Molybdenum Sulphide, Indium Sulphide, Tungsten Disulphide, Nickel Sulphide, Antimony Sulphide, Titanium Sulphide

Nitrides: Zinc Nitride, Molybdenum Nitride, Tungsten Nitride

Hybrid Inorganic/Organic polymers through ALD/MLD

Aluminium Oxide/Alucone, Zinc oxide/Zincone

The focal point of any technological advancement is to make the manufacturing processes more efficient in terms of usage of materials, energy, and time which ultimately translates to a lowering of cost. Making the technology cheaper would lead to percolation of technology giving access of the benefits to the masses. The technology should also be leaving a lower footprint on the environment when it comes to overall life cycle.

The outlook of “Thin Film Technology” and “Nanotechnology” is exactly this. Minimum Input and Maximum Output. The focus is to maximize the potential of any given material to derive the required end properties whether it is mechanical, electrical, optical, magnetic, etc. at the lowest possible cost.

The process of ALD closely mimics nature in that it deposits thin films one atomic/molecular layer at a time. The process is so controlled that the deposited thickness can be defined to the number of atomic layers required. The layers are extremely homogenous and can be deposited with precisely controlled properties and with a high degree of conformality even over irregular surfaces. The deposited films are pin-hole free and are highly packed. The entire process cycle ensures minimum usage of the materials for delivering the required properties and hence ensures most optimum utilization of resources.

The timing of the development is also ideal as the market for 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 by 2021 [BCC Research report Atomic Layer Deposition and other Ultrathin-Film Fabrication Processes (SMC061C)]. In this growth, one of the major markets for the ALD tool is going to be Asia Pacific with over 50 % of the market share [TMR Analysis, June 2016].

For the Indian customers, the ability to gain access to local support both in terms of the process hardware as well as the process recipes sets us apart from the other competitors. The product can be further customized with the required hardware and the software, in terms of the process recipes, to suit the requirement of the end-user. Looking forward, the system can be combined with various other PVD and CVD tools that HHV manufactures offering a range of combinatorial deposition routes which is hard to match.

With many of the other like-minded efforts being undertaken across the country, we would like to re-emphasize the support of HHV to the “Make in India” vision with “Made in India” systems, so that we can build up technologies from grass-root levels which can make the country technologically self-reliant and at the same time benefit the society at large.

Controlled Evaporation Source (CES)

Organic materials are increasingly playing an important role in many areas such as electronics, solar cells, and OLEDs.

These materials have several advantages over inorganic materials including low cost, high deposition rates and unique physical and optical properties. Most of these materials are highly temperature sensitive requiring precise temperature control.

The CES is a specialized thermal evaporation source offering precise temperature control for deposition of organic films and to dope electronic devices with organic materials in high and ultra-high vacuum environments

The CESs find applications in areas such as:

Organic Electronics

- OLEDS
- Organic solar cells
- Organic conductors

Surface Science

- Fundamental understanding of molecule-substrate interaction
- Understanding and control of surface supported supra-molecular structures
- Adsorption of molecules on vicinal surfaces

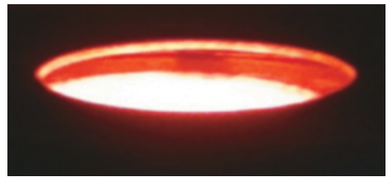
High Precision Epitaxial Film Growth

- Low-dimensional organic materials
- Nanoscale organic device fabrication
- Synthesis of novel organic materials
- Functional organic films
- Magnetic materials

HHV has successfully developed CES after 2 years of R&D to meet most of the requirements of the research community working in this area. The technical specs are as below:

Component	Specification
Crucible Charge Capacity	2 cc
Size	50 mm diameter x 75 mm height
Furnace Maximum Temperature	800 °C
Thermocouple	K - type
Heater Filament	0.35 Ω
Typical Current Requirement	16 A
Typical Voltage Requirement	35 V
Maximum Current	30 A
Maximum Voltage	60 V
Controller	
Type of Mounting	Standard 3U control rack
PID Controller	Eurotherm (2404 model)
Temperature Resolution	0.1°C
Output Channels	1
Supply Voltage	230V, 50 Hz
Size	483 (W) x 324 (D) x 132.6 (H) in mm

Controller



Controlled Evaporation Source

ATS500 Research and Production Coater

HHV's ATS500 is a highly versatile coating system, designed for advanced research and production. It features touch-panel control and can accommodate a wide range of process techniques, including thermal evaporation, electron beam evaporation, magnetron sputtering, and ion beam sputtering. The ATS500 is clean room compatible and offers high throughput and efficiency for applications such as lift-off coatings, OLED, organic electronics, photovoltaics, semiconductors, and for coating lenses and filters in optical applications.

The product build quality, features, and the customization options that are part of the ATS500 has attracted customers from various parts of the world. This product in a short period of time since development has been sold to various locations in China, Australia, Singapore, UK, US and to the Indian market. We have orders from other parts of globe and also from leading institutes in India. The ability of HHV to offer a wide range of customized solutions for various processes, and also build in its own recipes into the systems sets it apart from other manufacturers in the country. The value proposition and a global sales and service network sets it apart from the global competition.

Full range of deposition techniques:

- Resistance evaporation, single or multi-sources
- Controlled Evaporation Sources (CES) for OLEDs
- Electron beam sources from 6 kW upwards
- RF, DC, Pulsed DC sputtering
- Single and co-sputtering options
- Sputter up or sputter down (dedicated sputter systems)
- Standard Diffusion, Turbo, Cryo pumping options
- Rack panel provides space for thin accessories and power supplies
- Ion source options for substrate pre-cleaning or Ion Beam Assisted Deposition (CIBAD)

Film thickness monitoring and control:

The standard touch screen is available with an optional built-in film thickness monitor, while conventional thickness monitor and control options are available for the advanced user.

Mass flow and chamber pressure control:

ATS systems feature mass flow control for single, dual or multi-gas channels plus chamber pressure control systems.

Range of sample stages:

Includes rotation, heating and cooling, while further options for indexing, substrate bias, and z-axis lift for sample transfer.

Sample transfer:

Available on the ATS 500 with HHV's telescopic sample transfer system.

Chamber options:

Standard chamber is 500 mm x 500 mm and height and width options are available for specialist applications such as lift-off. The generous size allows multiple sources or deposition techniques to be accommodated.

High vacuum pumping:

- Vacuum system options include turbo pumps from 400 l/s to 1000 l/s and a 1500 l/s cryo pump is also available.
- Foreline pumps can be rotary or scroll.

High vacuum valve:

ATS turbo systems can be supplied with or without a high vacuum gate valve between chamber and high vacuum pump as process and preferences allow.

Ease of operation

- Colour touch screen control systems provide a clear user interface
- Process recipe control with password protection
- Auto/manual mode process accessory operation

HHV's ATS500 is highly versatile and provides the user access to a full range of deposition techniques from single or multi-source resistance evaporation to co-sputtering options. A rack panel provides space for thin accessories and power supplies to ensure that the system footprint is minimized. The system comes equipped with modern interfaces through colour touch screens and password protected recipe control to ensure that processes can be repeated and unchanged. HHV's ATS500 is the latest addition to its large array of thin film coating platforms and has been designed and manufactured to serve both the research and production markets worldwide.

India's Largest Optics Fabrication Facility at HHV

HHV's precision Optics Fabrication Lab (OFL) is equipped with state-of-art technology and machinery to fabricate high precision optical components in the visible and infrared spectrum. The facility is catering to the complex optical component requirements of space and defence sectors.

HHV has extensive knowledge on handling materials such as Quartz, Fused Silica, Zerodur, BK-7, Crown and Flint glasses for UV-Visible spectrum and Silicon, Germanium and Zinc Sulphide for the Infra-Red spectrum.

HHV's OFL is equipped with state-of-the-art machines for slitting, trepanning, curve generation, grinding, polishing, centring 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.

Optical processing	Description
Curve generation	To generate radius of curvatures up to 150 mm diameter.
Single side polishing with optical contact	For polishing of optical components up to 150 mm diameter with flatness up to λ/10.
Double side lapping machines	For lapping of optical components up to 150 mm diameter and up to 1 mm thickness with parallelism of 10 arc seconds.
Double side polishing machines	For polishing of optical components up to 150 mm diameter and up to 1 mm thickness with parallelism of 10 arc seconds.
Centering and edging for spherical and optics	Centering of lenses with 2-micron accuracy and OD turning up to 150 mm diameter using diamond wheel.

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

Specifications	Plano Windows	Prisms and wedges	Spherical Lenses	Domes
Flatness	λ/4	λ/4	λ/2	λ/2
Surface quality (S/D)	10-5	60-40	40-20	60-40
Parallelism	< 10 arcsec	-	<30 arcsec	1 arcmin
Maximum size	250 mm	203 mm	200 mm	200 mm
Minimum size	5 mm	25 mm	25 mm	-
Minimum thickness	0.5 mm	-	1 mm	3 mm
Centering	-	-	1 arcmin	
Radius tolerance	-	±0.1 mm	±0.1 mm	±0.05 mm

HHV manufactures over 100,000 optical components every year from periscope prisms to optical flats.

Heated Periscope Prisms for Battle Tanks and Submarines

Prisms are solid glass optics that are ground and polished into geometrical and optically significant shapes. The angle, position, and number of surfaces help define the type and function.

Since this initial discovery, prisms have been used in “bending” light within a system, “folding” the system into a smaller space, changing the orientation of an image, as well as combining or splitting optical beams with partial reflecting surfaces. These uses are common in applications with telescopes, periscope (figure 1), binoculars, surveying equipment, and host of others.

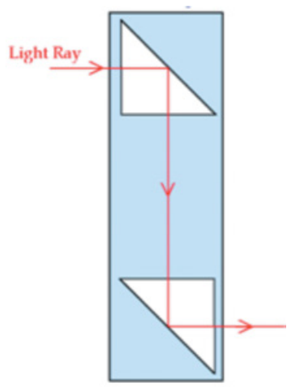


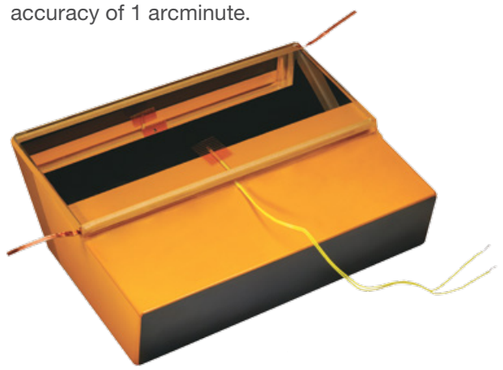
Figure 1. Periscope prisms

In order to be used successfully in most applications, prisms must be manufactured with very strict tolerances and accuracies. Due to the variability in shape, size, and, most importantly, the number of surfaces, prism manufacturing is quite complex. In addition, most high precision prisms require highly skilled manpower and technology.

The prisms are fabricated in HHV’s full-fledged in house Optics Fabrication Laboratory (OFL) where a plain glass is converted in to a prism using ultra-high precision machines.

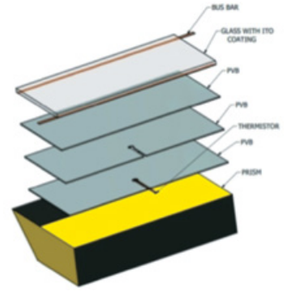
Figure 2. Prism Manufacturing Process

HHV’s optical fabrication laboratory is equipped with high quality machines for cutting, milling, lapping and polishing operations for prisms. HHV’s slitting machine is capable of achieving +/- 1 degree accuracy of cut, milling machine capable of maintaining parallelism and perpendicularity of 5 arcminutes accuracy. HHV has the capability to manufacture the prisms within 10 microns of dimensional tolerance, and has achieved flatness better than λ/10 for the entire 50 mm diameter with parallelism less than 5 arcseconds and angle accuracy of 1 arcminute.



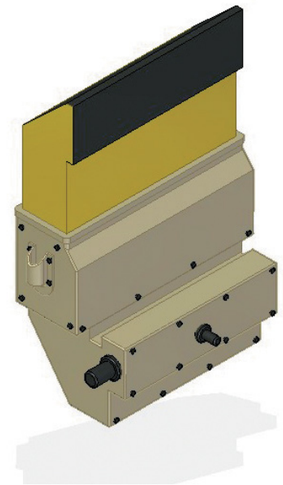
Periscope prisms consists of ITO coated heater plates that are laminated with prisms through an autoclave process for sealing and encapsulation. A Periscope makes use of two triangular prisms to change the direction of light by 90° . The reflective portion of the prism consists of a silver coating that is deposited directly on the prism through PVD processes. The reflective coatings are finished with protective paint to prevent it from atmosphere degradation. The entire assembly is bullet-proof and chemically inert.

HHV has the capability to manufacture prisms from 10mm to 250 mm in size. We manufacture over 700 large prisms every month that are used as periscope viewing devices.



HHV’s Periscope Prisms

- End to End technology development: The complete process cycle has been indigenously developed including optics fabrication, vacuum coating machines and coating technology, packaging including autoclave machine and associated process recipes, and all other intermediate steps.
- Training local manpower: Internal expertise has been developed which has been passed onto operator level personnel for carrying out the jobs thus making use of local manpower available, and thereby reducing cost burden.
- Custom Solutions available: Since the entire process flow is in control, any kind of customizations, and specifications can be easily achieved.
- Wide range of technology coverage: Autoclave machinery and process, and the transparent conductive oxide coatings developed have wide range of applications other than this area of development.



Horology

Multi-Faceted Watch Glasses

HHV’s horology division has recently developed multi-faceted glasses for the watch industry. This crystal has multiple faces which gives a more aesthetic look for the wrist watches. The company had earlier developed single face cut glasses and later has developed multi faceted cut glass.

These glasses have a dimension of approximately 30 mm and thickness of 2 mm. The division is capable of producing around 2000 numbers of these multi-faceted glasses per month depending on the specific design and dimensions.

This product has applications in the jewellery industry like stones and beads, and wrist watch industry in high end watches.

HHV also has the capability to carry out vacuum metallization like Gold, Silver and Rose Gold colours, and to manufacture silk screen printed glasses which will add the aesthetic appeal on wrist watches and provide a significant value addition for the final product.

Multi-Stage Dry Vacuum Pump for Pharmaceutical and Chemical Industries

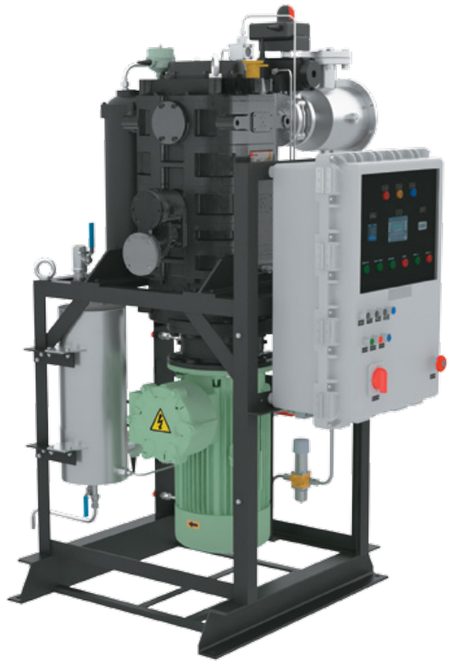
The Dry Vacuum Pumps are designed and developed for the Pharmaceutical and Chemical markets involving mainly distillation and drying applications. DP400 is a four stage and DP250 is a three stage dry vacuum pump. Roots and claw, and all claw combination make them versatile in applications.

The pump has a series of built-in features that are custom designed to suit the needs of the application. Oil-free, non-contacting, four stage roots and claw profile make it more suitable for pumping air vapour mixtures. It provides a consistent vacuum with high efficiencies, lowest cost of ownership with adequate safety and performance standards.

Some of the key features of the pump include:

- Four stage compression (DP400)
- Compact design
- Vertical mount
- Water cooled
- Cartridge-type inlet side bearing
- Relief valve
- Inlet purge
- Shaft seal purge
- Solvent purge
- Indirect cooling through thermosiphon principle
- Temperature control valve for constant temperature operation

The DP series pumps are widely accepted and acclaimed by our customers for its benefits in terms of performance and also on the shortest return on investment.



SP – Single stage Rotary Vane Vacuum Pumps

Single stage Rotary Vane Vacuum pumps are specially designed to work in high pressure applications ranging from a few hundred mbar down to 1 mbar. SP pumps are equipped with an optimally designed gas ballast valve. Internal oil filtration mechanism ensures that the exhaust is free from oil mist. The built-in exhaust mist filter also has a pressure relief valve in case of any back pressure build up within the pump.

Compact and air cooled pumps makes them industry ready with a plug and play type of installation. SP pumps accommodate various inlet accessories like an inlet dust filter and solenoid actuated valve to match the suitable requirement of the application. SPs are designed to fit on a trolley or buffer volume base making them more mobile and user friendly, wherever required.

HHV Pumps New Greenfield Facility

Located on the NH4 Bangalore-Mumbai highway at a place called T. Begur. It is approximately 28 km from Peenya Industrial Area, the nearest and biggest industrial area in Bangalore. The campus is widespread having an area of 51,500 sq. ft. with a built up area of 39,000 sq. ft.

This unit has an in-house Design and Development, Machine Shop and a state-of-the-art CMM (Coordinate Measuring Machine) facility. HHV Pumps has invested in new machineries and has set up a machine shop capable of manufacturing Aluminium and SG Iron parts as per the requirement. The unit has a production capability of 4,000 pumps a year.

The Research and Development Centre has been accredited with DSIR (Department of Scientific and Industrial Research) recognition recently. A systematic and a market driven approach towards design and development of new products every year keeps the team busy and helps in achieving more market share by entering into new applications.

Seminar on Vacuum Furnace Technology, 2019 Ahmedabad, India

HHV had organized a one-day seminar on "Vacuum Heat Treatment" in partnership with American Society of Metals' (ASM) Gujarat Chapter at Ahmedabad on the 13th of December 2019 to keep the scientific community in India abreast of HHV's capabilities in this area.

HHV's Managing Director Mr. Nagarjun Sakhamuri made a presentation detailing the company's capability in designing and developing a spectrum of vacuum furnaces for various metallurgical applications. Dr. Thyagarajan, a metallurgist with vast experience who closely works with HHV on various critical projects, discussed the importance of vacuum heat treatment, and brazing, and specifically spoke about aluminum brazing.

Heat Treat 2019 Detroit, Michigan

HHV Participated at the international exhibition organized by ASM - "Heat Treat 2019", the 30th heat treating society conference and exposition at Detroit, USA during October 15 - 17, 2019. HHV displayed its capability in the manufacturing of vacuum furnaces for metallurgical applications.

INCCOM-16, 2019 Thiruvananthapuram, India

HHV participated in the International Conference of Composites (INCCOM-16), held during September 20-21, 2019 at Thiruvananthapuram with the theme of "Advanced Composites and Challenges from Earth to Space".

HHV launched its new venture of ''Carbon/Ceramic Composite'' products manufacturing facility in Bangalore to cater to growing needs of users from Defense, Space, Aerospace and Automobile Industries. The salient components of this facility such as the Impregnator, Carbonizer, Graphitizer and Siliconization for carbon-carbon composite and ceramic carbon composite were showcased. The production capability ranges from carbon filament to composite parts in this manufacturing center.

International Conference on Optics & Electro-Optics, 2019 Dehradun, India

HHV participated in the International Conference on Optics & Electro-Optics, October 19th – 22nd 2019, to demonstrate its globally accepted range of thin films and optics products to the scientists, researchers, academicians, and students worldwide. It was well appreciated by the visitors and HHV received several enquiries as a result of the growing demand in this business segment.

Laser World of Photonics India, 2019 Mumbai, India

HHV's Thin Films and Optics division showcased its latest offerings in the area of Laser Optics, Optics fabrication, and its other offerings at Laser World of Photonics India, 17-19 October 2019, held at Mumbai.

The display of HHV's thin films and optics products generated plenty of footfall and received large number of enquiries from interested domestic and international customers.

Photonics Europe, 2019 Coventry, UK

HHV participated in SPIE Photonex Europe-2019 during 9-10 October 2019, at Coventry, United Kingdom and showcased its range of thin films and optics products. The team also gave a presentation on Laser Safety Glasses and their applications.

International Distributors' Meet, 2019 Bangalore, India

HHV hosted a meeting of international sales distributors in November 2019. Delegates visited from Australia, Brazil, France, Sweden and Vietnam with training provided by specialists from the UK group company HHV Ltd and the Dabaspet factory. Sessions included sales and marketing training and hands-on training on the BT150, Auto306 and ATS500 coating system product lines. Delegates also toured the new Dabaspet optical coating clean rooms, the special systems factory at Peenya, and the pumps facility at T.Begur during the visit.

HHV's international distributors with Managing Director Prasanth Sakhamuri on the lawns at Dabaspet, India

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