HHV WORLD

Vol 17, Issue 2, Aug-2025

Editorial

Building the Future with Precision and Purpose

Welcome to HHV World Vol 17, Issue 2 — our biannual window into the dynamic advancements, collaborations, and innovations that continue to shape the journey of the HHV Group, comprising of HHV Advanced Technologies (HHVAT) and HHV Thermal Technologies (HHVTT).

This issue captures a season of strategic momentum and national contribution. At the forefront, HHVAT marked a significant milestone by signing a Memorandum of Understanding with the Aeronautical Development Agency (ADA) at Aero India 2025. This landmark agreement will establish a robot-controlled sputter coating facility and enable the development of optically transparent and electrically conductive stealth coatings for the Advanced Medium Combat Aircraft (AMCA) integrated canopy — positioning HHVAT as a key partner in India's next-generation defense innovation.

Equally noteworthy, HHVTT entered into a Transfer of Technology (ToT) agreement with the Ministry of Defence to manufacture critical BrahMos missile components, including Carbon-Silicon Carbide throats and microwave absorbing structures — deepening our role in the indigenous defense manufacturing ecosystem.

Beyond defense, our presence resonated globally at forums like LWOP, Photonics West, SVC TechCon, ICEAMPS-2025, and Forensics Europe Expo, where we showcased advanced thin film and vacuum solutions across optics, semiconductors, and forensic science. The recognition of HHVAT with ISRO's Space Qualification Certificate for Micro Integrated Circuits further reinforces our commitment to precision engineering for space applications.

This issue also reflects our strong engagement with academia and future talent. Whether through impactful dialogues at INTENT 2025 (IIT Delhi), technical sessions at iCOLD25 and icONMAT, or our annual internship program, HHV is actively bridging research with real-world applications. Initiatives around employee well-being, safety culture, and sustainability practices (such as our observance of World Environment Day) reaffirm our belief that innovation must coexist with care — for our people, our planet, and our partners.

As always, we express our gratitude to our colleagues, customers, collaborators, and well-wishers who make this journey possible. Together, we are not just building advanced technologies — we are building a future grounded in purpose and progress.

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Strengthening High-Tech Manufacturing: Visit by Secretary, Government of India, MEITY Shri S. Krishnan

In a key moment for India's high-tech ecosystem, HHV Advanced Technologies Pvt. Ltd. had the honor of hosting Secretary, Government of India, MEITY Shri S. Krishnan at our facility earlier this year.

His visit underscored the growing alignment between industry capabilities and the national vision for technological self-reliance.

During the visit, Secretary, Government of India, MEITY Shri S. Krishnan was introduced to HHVAT's specialized competencies in vacuum systems, thin-film deposition, and precision optics, all of which play an integral role in sectors such as semiconductors, aerospace, photonics, and research instrumentation.

The discussions centered around:

1. India's strategic roadmap for electronics and semiconductor development
2. The role of Make in India in fostering domestic innovation
3. The critical need for cutting-edge research infrastructure
4. Creating a resilient and self-sufficient advanced manufacturing ecosystem

Secretary, Government of India, MEITY Shri S. Krishnan, shared thoughtful interactions with the HHVAT team reflected a shared commitment to building a strong industrial base for next-generation technologies, driven by indigenous talent and advanced engineering.

His visit served as an encouragement to continue pushing the boundaries of innovation, and it reaffirmed the importance of collaboration between government and industry in shaping India's technological future.

As part of our continued mission, HHV Advanced Technologies remains dedicated to supporting India's journey toward self-reliance and global leadership in high-precision manufacturing and engineering excellence.

Secretary, Government of India, MEITY Shri S. Krishnan, interacting with the HHV team during his visit to HHV Advanced Technologies.

Building a Widespread Photonics Ecosystem in India

With around 750 employees worldwide, the Indian Hind High Vacuum (HHV) Group develops and manufactures vacuum furnaces, high-precision optical components as well as customized systems for chemical and physical thin-film deposition (CVD/PVD).

In a joint venture with the India-based ASM Technologies it operates India's first solar and semiconductor focused equipment manufacturing facility which is manufacturing semiconductor tools, sub-systems and systems components. In this interview, HHV Advances Technologies Executive Director and Board Member Smriti Sakhamuri talks about the prospects of the photonics industry in India, the vacuum and thin-film technologies market and the importance of trade fairs such as Laser World of Photonics India for the local photonics community.

Ms. Smriti Sakhamuri, Executive Director – HHVAT, featured in Laser World of Photonics, sharing insights on thin-film innovation and India's photonics future.

Mrs Sakhamuri, could you please give us a brief introduction to the Hind High Vacuum (HHV) Group?

Smriti Sakhamuri: We are a -60year-old company which pioneered the manufacturing of vacuum pumps, solar panels, cryogenic vessels and vacuum furnaces in India. In fact, we were India's first vacuum science and technology company. We started off as a start-up out of the Indian Institute of Science. My grandfather S. V. Narasaiah founded HHV in 1965. He was driven by the dream to build zoom-lenses. He had travelled around the former USSR and documented the impact of World War II through his camera. Back in India he wanted to start manufacturing zoom-lenses. But he realized that there was a lack of essential technologies—i.e. vacuum coating systems. Together with the director of the Indian Institute of Science, he started to engineer solutions. India was a very poor country back then. We had limited access to materials and knowledge of thin films, optics or vacuum technologies. But, driven by his dream, they managed to engineer and build India's first vacuum pumps and thin film coating system companies.

Today, HHV Group offers vacuum furnaces and coating systems based on various chemical and physical vapor deposition (CVD/PVD) processes. How did you become a system and machine provider?

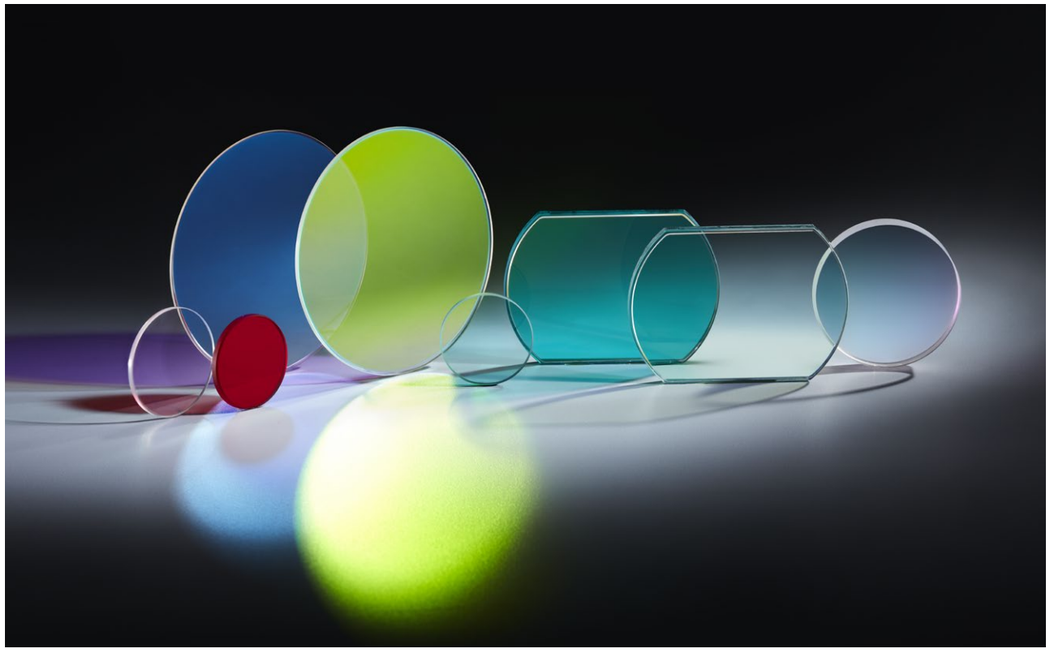
Sakhamuri: In the early years, during the cost-intensive development phase, our company ran out of monetary resources several times. In need of cash-flow, we started to provide systems and machines for external customers. Today our group consists of four companies. HHV Thermal Technologies, where we make large vacuum furnaces, space simulation chambers as well as graphitization and siliconization furnaces for various carbon composite materials. HHV Advanced Technologies provides thin film solutions, which include CVD- and PVD-coating machines, coating as a service and high precision optics. Our UK-based Company HHV Ltd. provides sales and services for our thin film coating equipment. The fourth branch is our joint venture with the India-based engineering specialist ASM Technologies which is engaged in the manufacturing of tools and sub-systems for the solar and semiconductor sectors. All in all, we have three manufacturing plants in Bangalore, around 750 employees and a global network of distributors. My grandfather's dream of building zoom-lenses has become true—and we offer thin-film and vacuum furnace equipment needed for critical applications. At first, people thought he was a bit crazy—to start a high-tech start-up in an under-developed environment with poor resources and lots of restrictions and embargos. But, he was convinced that India needs homegrown technologies—and he was ready to master the challenges in close collaboration with universities and research labs in India. Step by step and very hands-on our Group reached milestones like India's first coating system or India's first space simulation chamber.

Do you deliver your products primarily within India—or worldwide?

Sakhamuri: Over the years we have focused more and more on international standards to meet the expectations of global markets. Today we manufacture thin film coating equipment for space-qualified components. The focus on quality led to us operating India's leading vacuum flask and solar module production facilities. Also, in other industries we supply a growing base of global customers, for whom we manufacture various vacuum technology components like diffusion pumps. Today, we provide indigenous technologies to Indian companies and close the existing supply-gaps with our solutions. But we also deliver customized high-tech solutions throughout the world. Be it Vacuum Aluminum Brazing Furnaces for the world's largest headlight manufacturers or large Rotary Vacuum Brazing Furnaces for cryogenic engines which are used to launch satellite carriers to space. With some of our global customers we have been working together for more than 30 years. And some of our thin film coating machines are standard systems for many universities and research labs worldwide. Thousands of those systems are installed on a global scale and here in India we are the strongest coating brand.

In vacuum technology, you offer customized solutions in addition to standard systems. Which industries do you work for—and where are your customized solutions particularly in demand?

Sakhamuri: Coating of large telescope mirrors is an example of highly customized solutions. Today, India has strong space and astrophysics programs. Our coating solutions allow manufacturing mirrors of up to 4 meters and, we are also part of an international 30 m project based on Hawaii. Our optics—oftentimes with customized coatings—are delivered to customers in the UK, Italy, Germany, France apart from Asia and the USA. Laser-Safety applications, lenses for cinematography, or components for UV-lamps as well as entire assemblies are also in demand. The industries or clients we serve include aerospace, automotives, medical technologies, universities and R&D-Institutes. In some cases, we manage to translate highly customized solutions into standardized products for a broad range of customers and industries, which we manufacture in volume. But especially in the space and the optics industry, nearly every product is slightly customized.



CVD and PVD coating processes are highly advanced technologies. Has HHV engineered them in-house?

Sakhamuri: With the PVD we have in-house expertise right from making India's first coating system. Prior to acquiring Edward's thin film business in 2009 we used to manufacture equipment for their line. Since then, all machines have been sold under the HHV brand worldwide. We also collaborate closely with universities and advanced research labs here in India, to develop and optimize our CVD and PVD solutions. Recently we managed to build and supply the first indigenous Ion-Beam-Sputtering (IBS) System together with one of the leading Indian R&D-Institutes in this area. In the field of reactive sputtering for example, we cooperate with a large mobile phone manufacturer. They want to set up manufacturing plants here in India and are therefore building up relationships with domestic partners. Also, around CVD we are involved in collaborative innovation processes with R&D-and industry partners.

What role does photonics play in India today—and how do you assess its market potential?

Sakhamuri: To be honest, photonics is a small segment in India's manufacturing landscape. In terms of the global photonics enabled market, the value is in trillions of dollars. Here in India, we do a lot of phone or laptop-assemblies. But indigenous machines to manufacture semiconductors, coatings, heat treatment or optics still are a negligible part of the Indian GDP. But our government has realized the potential and started to act. In 2021 a study estimated the Indian photonics industry was worth 3,5 billion US-Dollar and expected it to grow at yearly rates of 12 to 15 percent. While this is still small, our industry is on a very dynamic growth path.

Are these assessments also the basis for your joint activities with ASM Technologies in the semiconductor market?

Sakhamuri: The reason why we set up this joint venture is that we are seeing this huge push for manufacturing in India. Large international telecom, semiconductor, machine vision and compressor manufacturing and design companies are taking aggressive steps to set up manufacturing plants and technological environments with R&D-labs and testing facilities in and around Bangalore. By seeing their encouragement, we felt that we should take our steps as the leading vacuum and thin film brand to enter the semiconductor and solar markets. We are seeing a lot of push from the government for their "Make in India"-strategy and in terms of building an ecosystem here. We don´t want to compete but to build together with global players and bring them together with our domestic ecosystem, that we have been establishing in the last 60 years.

How important is the Laser World of Photonics India for the development and expansion of the photonics industry in your region?

Sakhamuri: These kinds of shows are very important, particularly those with strong brand value. The Laser World of Photonics operates in multiple countries, attracts the leading global brands and is well organized. Being available on this platform gives a signal to the global photonics community, that there are companies like HHV in India. With that in mind, we recently took the step to be part of the LASER in Munich. With its strong brand recognition and value, we feel that it kind of reflects the same principles and philosophy that we also have as a company. Last year, the link up with electronica here in India was a huge success with a record number of visitors. At HHV we hosted a high-profile delegation with 35 CEOs from the leading Japanese vacuum technology companies through the Japanese Vacuum Association during the Laser World of Photonics India, which wouldn´t have happened without this fair.

Allow me to ask you a more personal question: are you an exception in your home country as a young woman on the board of a technology company—or are management levels becoming more permeable to female experts in general?

Sakhamuri: To be honest, I didn´t plan to join HHV. I am an economist and mathematician. I worked at the world bank for many years and thought of staying in that job for the rest of my life. What drew me to our family business was the philosophy of building indigenous technology and capability on the one hand but also having a strong mission within our family. We want to uplift every person who is working here. I joined HHV six years ago, when I was 29 years old. In fact, it is a challenge to see women in this space. Manufacturing in general and in photonics is more male dominated—not only in India but worldwide. But the gap is even bigger in India, perhaps because we have only a small number of deep technology companies here. That said I recently met a growing number of women in leading positions either in bigger scale companies or also in R&D labs. For example, I was pleasantly surprised to find a "Women in Optics Panel" on our last conference at the Indian Institute of Science. There are more women working in research than I was expecting. Our industry is starting to champion women in senior leadership positions, because companies realize diversity as an asset and that they need women's perspective to develop solutions for all their customers. I expect that we will see far more female leaders in the coming years because many obstacles that hindered them from moving up are now being removed. At HHV women have played an important role for decades. I was lucky to find wonderful and highly skilled female mentors when I joined the company. Here, I have the opportunity to lift up our workforce of around 750 people in a very concrete manner—be it education policies for their children or providing career opportunities or be it creating jobs by manufacturing essential technologies in the vacuum furnace, thin films and optics sectors.

So, in the end, your grandfather's dream came true in different ways. Not only is HHV capable of manufacturing zoom lenses and the needed technological building blocks, but also did his action activate your personal zoom lens: You zoomed into the life of 750 individuals and their families with very concrete results. Perhaps it was not what he intended to do, but what he managed to do.

Sakhamuri: That is a wonderful way to put his life's work and our company's history into perspective.

https://world-of-photonics.com/en/photonics-industry-portal/detail/building-a-widespread-photonics-ecosystem-in-india.html

Twin Door Metallizing System for Automobile Headlamps

HHV-TT has developed a large size high production rate vacuum metallizing system for coating head lamp and rear lamp reflectors for automobiles.

HHV-TT's twin door metallizing system has a large chamber of size 1200 mm diameter, 1800 mm height with a chamber volume (with door closed) of 5100 m3

It has been designed for a cycle time of 8-10 minutes thanks to highly rated pumping system.

Its configurations allow coating parts made of:

1. Thermoplastics (PC, ABS, ABS+PC, PC-HT, PA, PBT)
2. Thermosets (UP-BMC)

It is a sophisticated but easy to use system and accomplishes effective deposition on substrates with complicated shapes, sizes and with surface areas of 50 x 50 mm and depths from 2 to 200mm.

The system has an inbuilt process cycle which can be selected in any order as required:

1. Plasma pre-treatment of substrates using Argon as the process gas
2. Plasma Polymerisation CVD pre-treatment of substrates using HMDSO
3. Thermal Evaporation of Aluminium
4. Plasma Polymerisation CVD protective coating of substrates using HMDSO

The twin door mechanism with a highly rated pumping system helps to reduce process cycle times and increase output. It has two independent gas inlet systems, one for Argon to carry out glow discharge cleaning processes and the second for the monomer to carry out plasma polymerization process for pre-coat and post-coat of the reflectors.

A combination of rotary, roots pumps and a high vacuum pump enables a working vacuum of 1x 10-5 mbar in the chamber, thereby reducing process cycle time. The deposition source consists of tungsten filaments located on each door and connected to a bus bar. Two work holders are in each door and rotate during the metallization processes.

Each work holder has been designed to have a carrying capacity of 150 Kg. A glow discharge cleaning system has been provided for plasma pre-treatment of substrates. A thyristor controller monitors and controls the power on the filaments so as to avoid sudden changes in power that could cause deposition defects.

Computer based control instrumentations enable complete automation of vacuum and evaporation cycle by using PLC and SCADA software which also acquires various datas for each process cycle that can be stored and recalled. Necessary interlocks, safety alarms and controlled systems have been provided to ensure safety and ease of operations.

Fig 1. Twin Door Metallization System

Autoclave System for Aerospace Components

HHV-TT design and develop a range of vacuum technology based customized autoclave systems from a lab scale to a large industrial horizontal type of autoclave systems as per ASME pressure vessel codes safety standards for a variety of applications.

The Autoclave evolved over the years and became an essential facility today to process advanced composite materials to produce structural components, very large aircraft components such as wings and fuselage, etc.

As a manufacturer of special purpose high vacuum equipment HHV-TT has the capability and understanding of diverse and complex requirements of aircraft industry and to produce materials for aircraft parts while designing and developing autoclave systems.

HHV-TT's autoclave system has the unique design of electro - mechanically operated dished door with lock ring to seal tightly against rated pressure and at the highest chamber temperature, an audio-visual system with a rotating light gets activated while opening the door, easy loading by a trolley mechanism.

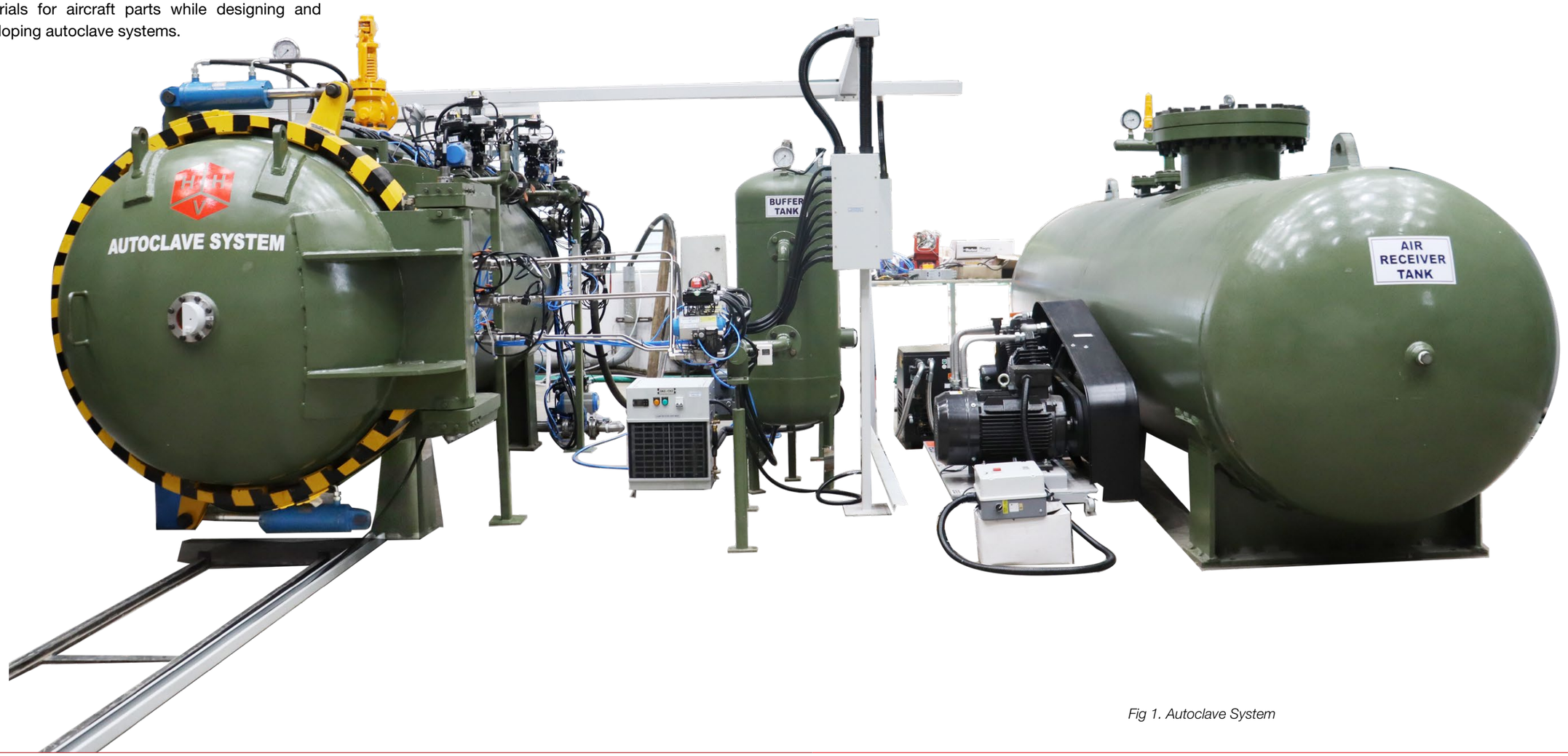


Fig 1. Autoclave System

The automated autoclave system includes:

- IPC and SCADA enable the user to monitor the cure parameters in real-time, both for data-logging purposes and also for cure optimisation.
- IPC and SCADA facilitates to overcome ever increasing pressures on productivity, drive to achieve reduced cure cycle times, while maintaining product quality and repeatability

Applications:

- To produce very large aircraft components such as wing and fuselage.
- Can process a wide variety of materials, including thermo set and thermoplastic based composite aircraft parts with varying contours and complex shapes.

UHV Magnetron Sputtering System for Metals, Di-Electrics, and Compounds Deposition

HHV Advanced Technology (HHVAT) has been a trusted reference in high-quality thin-film deposition systems for research and development applications over the decades.

HHVAT's recent installation includes a UHV Magnetron Sputtering System in Sweden at a globally recognized institute for thin-film research. The system is a compact, high-performance sputtering platform designed for depositing metals, metal oxides, and nitrides, particularly in R&D settings. The main deposition chamber is fabricated from stainless steel with electropolished inner walls and features a cylindrical design with an approximate inner diameter of 24 inches and a height of 20 inches. To preserve chamber integrity and minimize contamination, the inner surfaces are protected by a set of easily replaceable liners.

The chamber is equipped with six 2-inch diameter magnetron sputtering sources mounted on the top flange in a confocal, sputter-down arrangement. Provision is also made for a seventh magnetron for direct sputtering if required. The substrate holder is positioned at the chamber base, with an adjustable distance of approximately 2 inches from the sources. Pumping is achieved through a high-capacity 1600 l/s turbomolecular pump connected via a pneumatically actuated gate valve in combination with throttle valve. For roughing, the system employs dual sorption pumps isolated by an all-metal sealed valve. Under clean and properly baked-out conditions, the system can achieve ultimate vacuum levels in the 10^{-8} Torr range. Optional enhancements such as cryopumps or additional turbopumps are available based on user needs.

An integrated load-lock chamber enables quick sample transfer while maintaining vacuum integrity. This chamber is designed to accommodate 4-inch diameter substrates and is independently pumped by an 85 l/s turbomolecular pump backed by a dry pump. Base pressures in the load-lock can reach the 10^{-7} Torr range under clean, dry conditions. Pressure control is managed through a combination of a throttle valve, isolation gate valve, and PID-regulated feedback from an absolute pressure gauge, with upstream regulation possible via mass flow controllers.

The substrate holder, located inside the main chamber, is designed to hold 4-inch wafers and is heated by a high-temperature SiC heater capable of exceeding 1000 °C. A dedicated RF power supply is provided for substrate biasing. Each magnetron is powered by a 300 W RF generator, which includes an automatic matching network. A switch-box system enables RF power to be selectively directed to individual magnetrons as needed, providing excellent flexibility for multi-layer or co-sputtering processes.

Fig.1. UHV magnetron Sputtering System

The system supports both manual and fully automated modes of operation, including recipe-based process control through an integrated sequencer. A real-time data acquisition system continuously monitors and records all critical process parameters, displaying them graphically and logging them with time stamps for post-process analysis or integration with external diagnostic tools. The operator has the flexibility to pause and resume processes as needed. Built-in remote communication capabilities enable remote diagnostics, monitoring, and client support. The entire control system is housed within the system frame, and user interaction is facilitated via a front-mounted touchscreen interface that provides intuitive and efficient control. The system delivers excellent film uniformity, achieving a thickness non-uniformity of ±3% across a 4-inch wafer.

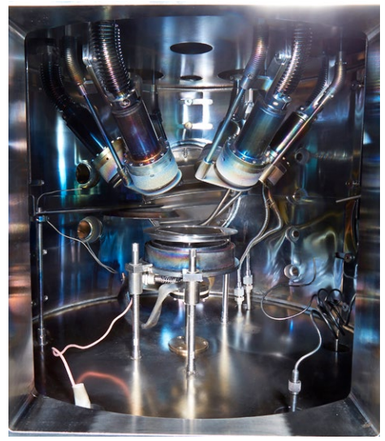


Fig.2. Internal view of the process chamber

Parameter	Specification
Chamber Dimensions	Ø600 mm × 500 mm (Height)
Pumping System (Process Chamber)	Standard: Turbomolecular pump + Dry scroll pump Optional: Cryogenic pump + Scroll pump
Ultimate Vacuum	≤ 5 × 10^{-8}mbar (after proper bake-out and under clean conditions)
Magnetron Sources	2" diameter × 6 units in confocal arrangement Provision for 7th source (direct sputtering)
Sample Holder Features	Rotation up to 20 rpm Heating up to 1000 °C Water cooling RF/DC bias capability
Load-Lock Chamber	Compact chamber for 4" substrate Magnetically coupled, fully automatic substrate transfer
System Control	Fully automated PLC-based control with SCADA interface

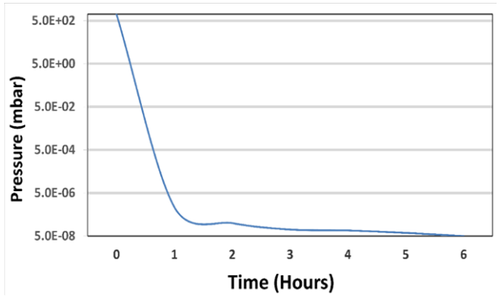


Fig.3. Internal view of the process chamber

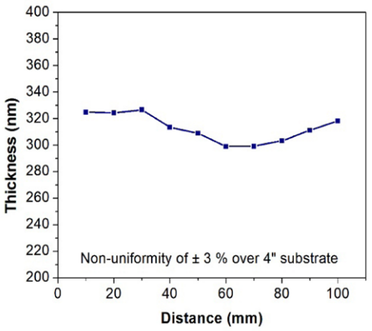


Fig.4. Thickness non uniformity profile.

Pushing the Frontiers of Thin-Film Deposition: TF 1000 Ion-Assisted E-Beam System

HHV Advanced Technologies (HHVAT) continues to lead innovation in the domain of thin-film coating systems, with a clear focus on enabling advanced research and precision manufacturing.

The latest in our series of specialized systems is the Ion-Assisted Electron Beam Deposition System, Model TF 1000, which represents a high-end solution for the fabrication of complex multilayer thin-film structures.

Designed for the development of optical multilayer thin-film devices, the TF 1000 supports a wide variety of materials, including dielectrics, semiconductors, ceramics, composites, and metals. Its capacity to accommodate up to four polished substrates simultaneously—each up to 150 mm in diameter—makes it a versatile and powerful system for demanding deposition needs.

A defining feature of this system is its dual electron beam sources and integrated end-hall ion source, allowing both substrate pre-cleaning and ion-assisted deposition in a fully synchronized mode. This combination ensures improved film adhesion, density, and optical performance. Deposition uniformity is maintained at ≤ 3% across individual substrates and ≤ 2% between adjacent ones—ideal for high-precision optical applications.

The system provides real-time in situ thickness monitoring via a quartz crystal and an optical thickness monitor, both integrated seamlessly with the system's automation controls. Operators benefit from a touchscreen interface with a PLC-based SCADA system, offering complete command over vacuum cycles, deposition sources, power supply controls, and real-time residual gas analysis (RGA).

Fig.1. TF 1000 Ion Assisted E-Beam System

The TF 1000 includes two substrate holder options:

- A dome-shaped calotte with backside heating up to 450°C
- A detachable GLAD (Glancing Angle Deposition) stage for tilted deposition up to ±90°

With a vacuum base pressure better than 5×10^{-7} mbar, this system sets the benchmark for stability and repeatability in ion-assisted coatings.

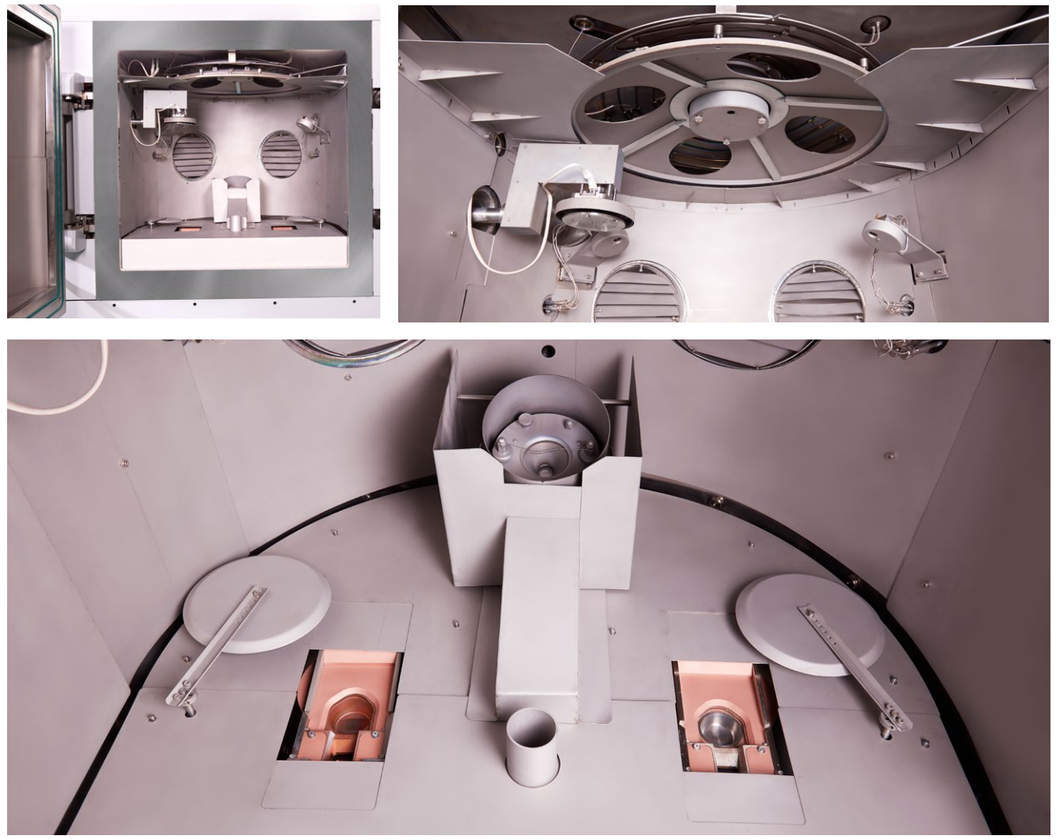


Fig.2. Internal view of the TF 1000

Technical Specifications

Parameter	Specification
Model	TF 1000
Vacuum Chamber Size	1000 mm (L) × 1000 mm (W) × 1000 mm (H)
High Vacuum Pump	Two turbomolecular pumps (2150 lit/sec each)
Pre Vacuum Pump	Multistage Roots pump, 88 m³/hr.
Ultimate Vacuum	≤ 5×10^{-7} mbar
Electron Beam Sources	4 × 35cc, 10KW (Two sets)
Ion Source	End-hall type ion source
Sample Holder 1	Domed-type with rear-side heating up to 450 °C
Sample Holder 2	Removable GLAD stage with ±90° tilting
In-situ Thickness Monitors	Two six-crystal sensors + one optical thickness monitor
System Control	Fully automated, PLC-based with SCADA interface
Thickness Uniformity	< ±3%

Advancing Optical Manufacturing: Development of High-Precision Aluminium Mandrel

HHV Advanced Technologies continues to reinforce its position as a leader in the manufacturing of precision infrared optics through the successful development of a high-accuracy aluminium mandrel, designed and fabricated using single-point diamond turning (SPDT) technology.

This mandrel serves as a critical component in the production of complex reflective optical systems.

The aluminium mandrel is a monolithic structure that seamlessly integrates both hyperbolic and parabolic surface profiles, enabling compact and high-fidelity optical configurations. Such a design is particularly advantageous for applications requiring precise beam shaping and alignment, including off-axis parabolic mirrors, ellipsoidal mirrors, and other advanced IR optical elements.

Fabricated from a high-grade aluminium alloy, the mandrel material was chosen for its excellent machinability, dimensional stability, and compatibility with diamond turning. Being a non-ferrous alloy, it also ensures an oxidation-free surface finish post-machining, thereby contributing to superior surface quality and consistency.

To ensure mechanical stability and minimize deflection during the precision machining process, a custom work-holding mechanism was employed. The turning operation was carried out using a natural diamond cutting tool—preferably suited for achieving ultra-smooth finishes on non-ferrous metals. Upon completion of the initial turning stage, the component was evaluated using a Talysurf surface measurement instrument from Taylor Hobson.

The measurements confirmed adherence to stringent quality standards, with:

- Profile error maintained below 0.2 µm
- Surface roughness achieved below 8 nm

Subsequently, the part underwent an electroless nickel plating process to enhance its structural and surface properties. This was followed by a secondary diamond turning operation to refine the plated surface and approach the final required specifications.

In the final stage of the process, a 200 µm thick shell was extracted from the mandrel through precision electroforming. This shell structure serves as the finished optical element, exhibiting both mechanical integrity and optical accuracy.

The successful completion of this project underscores HHV Advanced Technologies' capabilities in delivering high-performance solutions for demanding optical applications. By combining advanced materials, ultra-precision machining, and surface engineering, the organisation continues to support the evolving needs of defence, aerospace, and scientific sectors with cutting-edge optical technologies.

Engineered through complex precision machining and demanding plating controls, these mandrels help produce lightweight, high-resolution mirror modules for space telescopes. Mandrel mirrors can achieve angular resolutions of 30 arcseconds to 50 keV, making them suitable for high-energy X-ray imaging. Our nickel-coated aluminum mandrel is now driving innovation in high-resolution X-ray optics.

Diamond turned mandrel

Fig.1. Before plating

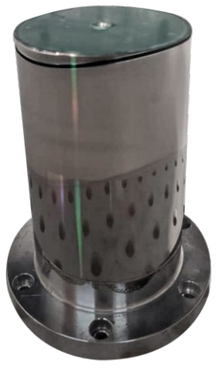


Fig.2. After plating

High efficiency ARC for LWIR Wavelength on Chalcogenides

In a world increasingly driven by sensing technology and optical precision, Infrared Glass (IRG) materials are quietly shaping the future, especially in industries ranging from defense and aerospace to environmental monitoring and medical diagnostics.

IRG is a family of specialty glasses designed to be transparent in the infrared (IR) spectrum, typically beyond the reach of visible light, covering wavelengths from around 1 to 14 micrometres. IRG glasses are generally composed of chalcogenide elements such as Sulphur (S), Selenium (Se), or Tellurium (Te) combined with metalloids or metals such as Arsenic (As), Germanium (Ge), or Antimony (Sb). These ingredients give IR glasses, excellent infrared transmission, low dispersion, ideal for creating high-quality lenses and non-hygroscopic properties.

Chalcogenide glass stands out among infrared substrates for its broad IR transmission, making it ideal for both MWIR and LWIR applications. Unlike crystalline materials like Germanium or Zinc Sulphide or Zinc Selenide. They offer low dispersion and a stable refractive index over temperature, which is a major advantage in designing athermal and colour-corrected systems. Compared to Germanium, chalcogenides are lighter and less sensitive to temperature shifts, and they can be tailored to meet specific optical needs.

Anti-reflective (AR) coatings on chalcogenide substrates are essential for enhancing infrared transmission and minimizing surface reflections, which can otherwise reach up to 30%. They benefit from multilayer AR coatings that reduce reflection across the targeted IR bands, that are typically optimized for mid-wave (3–5 µm) (MWIR) and long-wave (8–12 µm) (LWIR) infrared bands, depending on the application making them ideal for thermal imaging, sensing, and IR laser systems.

Additionally, with DLC coating, improved durability and performance in harsh environments can also be achieved.

We have successfully developed a high-efficiency anti-reflective (AR) coating on IRG substrates optimized for LWIR applications. The coating achieves an impressive average reflectance below 0.5% and average transmittance exceeding 98.5%. In addition to superior optical performance, the AR-coated IRG substrates have passed all key durability tests.

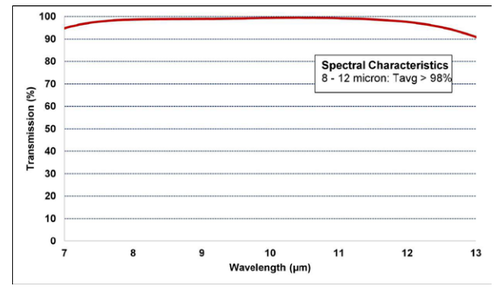


Fig.1. Reflectance and transmittance spectra of the optimized coating.

Fig.2. Chalcogenide components coated with ARC

Forging Aerospace Innovation: HHVAT Signs MoU with ADA at Aero India 2025

At Aero India 2025, HHV Advanced Technologies (HHVAT) marked a defining moment in its journey toward strengthening India's aerospace ecosystem by entering into a strategic Memorandum of Understanding (MoU) with the Aeronautical Development Agency (ADA).

The MoU, formalized between Jitendra Jaisingh Jadav, Director General – ADA, Ministry of Defence, and Mr. Prasanth Sakhamuri, Managing Director – HHVAT, lays the groundwork for establishing a robot-controlled sputter coating facility and advancing electrically conductive and optically transparent stealth coatings for the Advanced Medium Combat Aircraft (AMCA) integrated canopy.

This collaboration not only underscores HHVAT's technical leadership in thin-film deposition and vacuum engineering but also reflects a shared vision to bolster indigenous defense manufacturing. Now featured in this issue of HHV World, this milestone exemplifies how HHV continues to play a pivotal role in developing technologies of national strategic importance.

MoU signing ceremony at Aero India 2025 between HHVAT and ADA, marking a new era in advanced aerospace coatings.

Advancing Defense Manufacturing: HHVTT Signs ToT for BrahMos Missile Components

In a notable development showcased at Aero India 2025, HHV Thermal Technologies (HHVTT) signed a significant Transfer of Technology (ToT) agreement with the Ministry of Defence, Government of India.

This collaboration empowers HHVTT to manufacture high-value, mission-critical components for the BrahMos missile system, including Carbon-Silicon Carbide (C-SiC) throats, Jet Vanes, and Microwave Absorbing Structures.

These components play a pivotal role in enabling precision guidance, advanced propulsion, and stealth capabilities in one of the world's fastest supersonic cruise missiles. The ToT marks a strategic step in HHVTT's ongoing journey to contribute to India's defense self-reliance by bringing complex technologies into indigenous production.

Featured in this edition of HHV World, this agreement reaffirms HHVTT's unwavering commitment to strengthening the nation's high-tech defense manufacturing ecosystem through innovation, materials excellence, and deep engineering expertise.

ToT Signing Ceremony at Aero India 2025 – HHVTT and Ministry of Defence join hands to power BrahMos with indigenous manufacturing strength

HHVAT Achieves Space Certification for Micro Integrated Circuits Fabrication

In a proud milestone for India's growing space ecosystem, HHV Advanced Technologies (HHVAT) has been awarded the Space Qualification Certificate for its Patterned Hybrid Micro Circuits (HMCs) fabrication process.

The certificate was formally presented by Smt. Ramalakshmi N, Associate Director (R&D), U R Rao Satellite Centre (URSC), ISRO — a moment that recognizes HHVAT's ability to meet the stringent quality, reliability, and performance standards required for satellite payloads and space applications.

This certification validates the company's 4-layer Micro Integrated Circuits Fabrication Processes, which are critical to the success of high-performance electronic systems used in advanced space missions. It marks yet another step in HHVAT's steady rise as a trusted indigenous partner in India's space endeavors.

By developing space-certified microelectronic solutions, HHVAT reinforces its commitment to enabling national missions with world-class precision engineering. As we highlight in this edition of HHV World, this achievement stands as a testament to our mission of delivering Make in India innovations that align with the highest global standards.

HHVAT team receives the Space Qualification Certificate from URSC, ISRO for its high-precision microcircuit fabrication technology.

Prioritizing Wellness: Annual Health Check-Up Reinforces HHVAT's People-First Approach

At HHV Advanced Technologies (HHVAT), employee wellness is not just a program — it's a core part of our values. As part of our ongoing commitment to a healthy and resilient workforce, HHVAT recently organized its annual comprehensive health check-up camp at our manufacturing facilities.

The initiative provided employees with access to on-site diagnostic screenings, medical consultations, and personalized health insights. By encouraging regular health monitoring, the program fosters greater awareness of preventive care and early intervention.

More than just a medical initiative, the camp reflects HHVAT's belief that a culture of care is essential to long-term excellence — both for individuals and the organization. In this edition of *HHV World*, we spotlight how such programs continue to strengthen our team's well-being, motivation, and performance.

HHVAT employees participating in the annual health check-up camp—promoting wellness at the workplace.

Reaffirming Our Commitment to Safety: National Safety Week at HHV Group

__HHV Group__ marked the __54th National Safety Week__ with a strong focus on promoting a __Zero Harm culture__ across all facilities. From shop floors to office spaces, safety continues to be a collective responsibility embraced by every employee.

The observance included **awareness campaigns, safety drills, and interactive sessions**, reinforcing best practices and encouraging active participation in workplace, community, and personal safety. With this year's theme, **"Safety is a Continuous Responsibility,"** the Group reaffirmed its commitment to maintaining high standards through training, infrastructure, and a strong culture of care.

HHV team members participating in National Safety Week 2025 initiatives promoting awareness, preparedness, and prevention.

Celebrating Women in Science and Engineering at HHV

On __International Women's Day 2025__, HHV – Hind High Vacuum Company Pvt. Ltd. celebrated the remarkable contributions of women across the organization.

From research labs and technical operations to project leadership and strategic roles, women at HHV continue to play a vital role in advancing vacuum, optics, and thin film technologies.

This year's theme echoed strongly within our teams: **Empowering Women in STEM**. It was a day of reflection, appreciation, and renewed commitment to fostering an inclusive workplace where women thrive and lead in science, engineering, and innovation.

As we continue our mission of excellence in high technology, we remain dedicated to creating equal opportunities and nurturing the next generation of women leaders.

Women team members of HHV being recognized for their role in shaping science and innovation on Women's Day 2025

61 Years of Innovation, Growth, and Legacy – Foundation Day Celebrated at HHV

*On **April 10, 2025**, **Hind High Vacuum Company Pvt. Ltd. (HHV)** celebrated a proud milestone—**61 years** of pioneering excellence in vacuum systems, thin film coatings, and precision engineering.*

The occasion served as a meaningful reflection of HHV's enduring legacy, its technological strides, and its unwavering commitment to innovation and nation-building.

The Foundation Day celebration was held at the **HHV Thermal Technologies campus**, beginning with a traditional **lamp-lighting ceremony** and welcome address. The event was marked by presentations from key divisions—**TFED, TFOD, Systems, R&D, and Carbon Composites**—highlighting significant progress and next-generation initiatives.

Addressing the gathering, **Mr. Nagarjun Sakhamuri**, **Mrs. Leela Amaraneni** (on behalf of Mr. Prasanth Sakhamuri), and **Ms. Smriti Sakhamuri** shared their thoughts on the company's journey, reaffirming a collective vision for sustainable growth, technological leadership, and human capital development.

The event also recognized the contributions and excellence of HHV employees through:

- **26 Performance Excellence Awards**
- **1 Long Service Award**
- **53 Academic Scholarships**

These recognitions reflected HHV's continued emphasis on employee development, organizational excellence, and a culture that values performance and learning.

The day concluded with **lively conversations and camaraderie over high tea**, bringing together employees, leadership, and guests to commemorate the achievements of the past and renew commitment to the future.

Team HHV gathers to celebrate 61 years of innovation, people, and progress at Foundation Day 2025

Empowering Young Minds – Internship Program 2025 at HHV Advanced Technologies

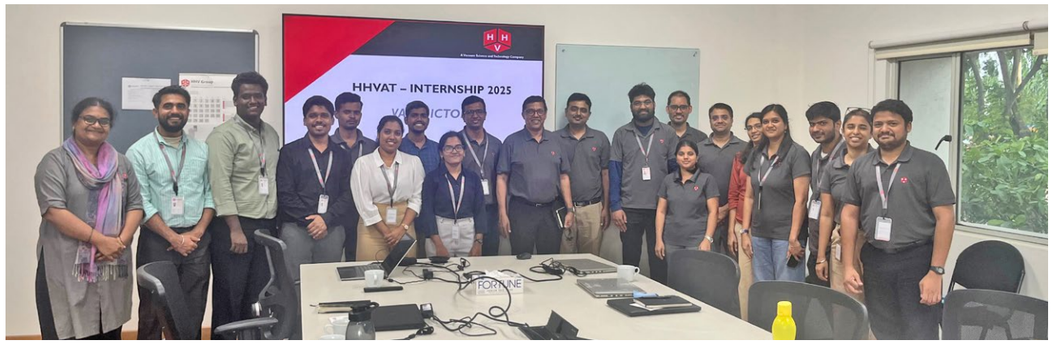
HHV Advanced Technologies successfully completed its annual six-week internship program, welcoming a group of bright and motivated engineering students for an immersive experience in advanced technologies.

Over the course of six enriching weeks, five talented interns — Srija M, Kumar Shivam, Akarshit Nandeshwar, Mohammed Mufeedh Kappil, and Nayana K V — immersed themselves in hands-on learning and practical exposure at HHV Advanced Technologies (HHVAT). The internship provided them with a unique opportunity to work closely on cutting-edge projects involving thin film coatings, vacuum systems, and photonics — key technologies shaping the future of science and engineering.

The program was formally inaugurated by Mr. Prasanth Sakhamuri, Managing Director, and Ms. Smriti Sakhamuri, Executive Director, reflecting HHVAT's enduring vision to bridge academic learning with real-world industrial applications.

he internship culminated on July 4th, 2025, with a valedictory function that celebrated the interns' journey, achievements, and contributions. The event was marked by warm interactions, certificate presentations, and reflections on a transformative experience for both the students and their mentors.

With initiatives like this, HHVAT continues to foster innovation and nurture the next generation of scientific thinkers and technologists.



The 2025 intern batch with HHVAT leadership during the program's inauguration.

World Environment Day 2025 — Committing to a Greener Future at HHV

*On **June 5, 2025**, HHV – Hind High Vacuum Company Pvt. Ltd. joined the global movement to mark **World Environment Day**, echoing this year's theme: **"Beat Plastic Pollution."***

The occasion was a call to action for organizations and individuals alike to take meaningful steps toward environmental stewardship.

At HHV, innovation is guided by responsibility. Our vacuum deposition and thin-film coating systems are designed to support cleaner technologies in critical fields such as **space exploration**, **medical imaging**, and **environmental sensing**—sectors where sustainability is increasingly non-negotiable.

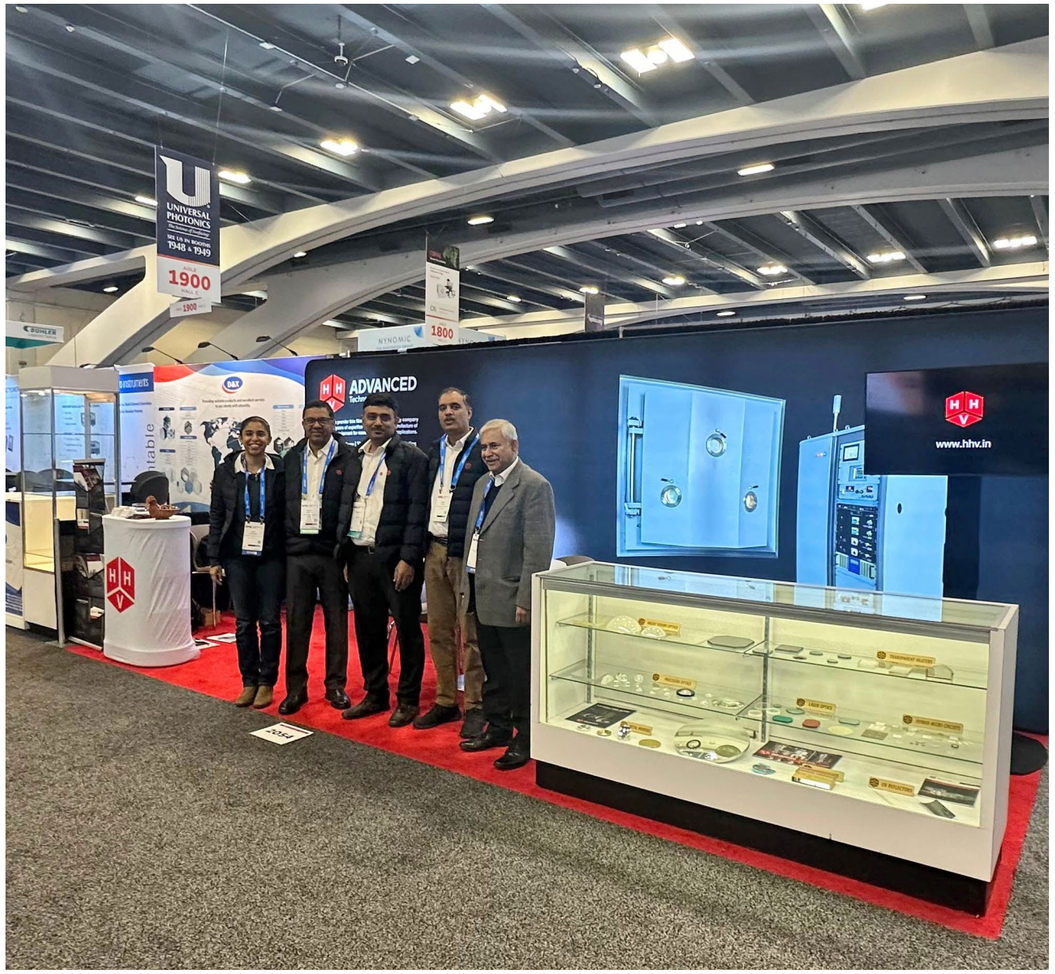
As part of our ongoing commitment to sustainable development, we have:

- Adopted eco-conscious practices in our operations
- Focused on reducing plastic waste
- Promoted awareness within the HHV community

We firmly believe that **technology and nature must progress together**, and we remain dedicated to building solutions that serve not only human advancement but also the health of our planet.

HHV team pledging to reduce plastic waste and build a more sustainable future on World Environment Day 2025.

HHVAT at Photonics West 2025
- SPIE, San Francisco, USA



Team HHVAT at Booth 2054 – Engaging global visitors with innovations in vacuum coating and precision optics at Photonics West 2025, San Francisco.

HHV Advanced Technologies marked a strong presence at Photonics West 2025, the world's premier event for photonics, optics, and imaging innovations, held in San Francisco. At Booth 2054, HHV showcased its advanced capabilities in vacuum coating systems, thin-film deposition technologies, and precision optics, drawing interest from researchers, OEMs, and global technology leaders.

Our exhibit featured high-performance platforms designed for R&D and production across sectors like aerospace, semiconductors, and photonics.

The event served as a dynamic platform for HHV to engage with key stakeholders, explore future collaborations, and reinforce our position as a global enabler of photonics innovation.

Through live demonstrations and meaningful dialogue, Team HHV highlighted how our solutions are addressing the evolving demands of next-generation optical systems.

HHVAT at iCONMAT 2025,
- CUSAT, Kochi

Dr. Sreenivasan M.G. delivering his talk on thin film innovations at icONMAT 2025; Team HHVAT engaging with attendees at the exhibit booth.

HHV Advanced Technologies was proud to be an official sponsor of the **4th International Conference on Optoelectronic and Nanomaterials for Advanced Technology (icONMAT 2025)**, held at **CUSAT, Kochi, Kerala**. The event brought together researchers, technologists, and students from across the globe to explore breakthroughs in nanomaterials and optoelectronics.

Representing HHV's technical leadership, **Dr. Sreenivasan M.G., Chief Technology Officer**, delivered a keynote session on **"Thin Film Coatings for Advanced Technologies,"** highlighting recent advancements and applications in precision coatings for emerging fields.

Our exhibit booth served as a hub for interaction, where the HHVAT team engaged with budding scientists, researchers, and students—sharing ideas, discussing challenges, and encouraging collaboration in the future of materials science.

Bridging Academia and Industry: HHVAT at INTENT 2025, IIT, Delhi

Ms. Smriti Sakhamuri, Executive Director – HHVAT, represents HHV Advanced Technologies at INTENT 2025, engaging with industry leaders and academic experts at IIT Delhi.

In a landmark initiative to advance collaboration between industry and academia, **INTENT 2025** — hosted by the **Indian Institute of Technology (IIT) Delhi** — convened some of India's leading minds in technology, innovation, and applied research. At the heart of this event was a powerful panel discussion on **"The Path to a Productive Ecosystem for Industry & Academia Partnership."**

Representing HHV Advanced Technologies and the broader advanced manufacturing sector, **Ms. Smriti Sakhamuri**, Executive Director and Board Member, brought critical perspectives to the table. Her participation reflected not only HHV's leadership in high-tech manufacturing but also its commitment to cultivating future-ready talent and fostering innovation that is grounded in real-world applicability.

Moderated by **Prof. Krishna Balasubramanian** and **Prof. Ankur Goswami** of IIT Delhi, the panel featured a distinguished lineup of experts across industries. However, it was **Ms. Sakhamuri's voice that emphasized the urgent need for deeper alignment between research institutions and the demands of high-precision manufacturing**.

In her remarks, she addressed:

- The value of **industry-guided academic research** in driving national competitiveness
- The role of **applied innovation** in bridging lab-scale discovery with scalable production
- The importance of creating **practical exposure opportunities** for students, especially in emerging fields like photonics, vacuum engineering, and microelectronics

Ms. Sakhamuri also advocated for a culture of **cross-disciplinary learning and hands-on experience**, ensuring that the next generation of engineers and scientists are equipped to contribute meaningfully to India's high-tech future.

Her leadership presence at INTENT 2025 underscored HHV's strategic vision — one where education, innovation, and industry work hand in hand to build a resilient and self-sustaining technological ecosystem.

HHV Advanced Technologies remains firmly committed to enabling such dialogues, and to playing a proactive role in shaping the future of **engineering excellence in India**.

HHVAT at iCOLD25,
- IIT, Hyderabad

HHV Advanced Technologies team at iCOLD25, engaging with researchers and delegates from across the thin-film community.

HHV Advanced Technologies proudly participated in and sponsored **iCOLD25**, a premier conference held from **March 6–8, 2025**, at **IIT Hyderabad**. The event served as a dynamic platform for researchers and industry leaders to converge and explore the latest in **layer deposition techniques**, **material behavior**, and **device fabrication technologies**.

Our team engaged with attendees at the HHV booth, showcasing innovations in **thin-film deposition systems** and building meaningful dialogue around the future of vacuum and coating technologies.

We thank all the visitors who stopped by and look forward to continuing collaborations that drive innovation in advanced materials and processes.

HHVAT at COSEin,
- IISc, Bangalore

HHV Advanced Technologies joins thought leaders at Nano Electronics Roadshow 2025 to support India's semiconductor ambition.

HHV Advanced Technologies participated in the Nano Electronics Roadshow 2025, a landmark initiative organized under the COSEin Conference in collaboration with the Ministry of Electronics and Information Technology (MeitY) and six premier academic institutions. Bringing together policymakers, researchers, startups, and industry leaders, the roadshow fostered meaningful dialogue on India's rapidly evolving semiconductor and nanoelectronics ecosystem. As semiconductor manufacturing takes center stage in the country's technological roadmap, HHV's presence reflected its commitment to advancing fabrication technologies and contributing to national self-reliance in electronics and advanced materials.

Startup Mahakumbh 2025, New Delhi:
Ms. Smriti Sakhamuri, Executive Director – HHVAT, Champions Innovation in Precision Manufacturing

Ms. Smriti Sakhamuri, Executive Director – HHVAT, shares her insights during the panel discussion on Innovation in Precision Manufacturing at Startup Mahakumbh 2025.

Startup Mahakumbh 2025 stood out as one of India's most significant platforms for entrepreneurial dialogue and national innovation strategy — bringing together policymakers, investors, founders, and industry leaders for a three-day exchange on the future of Indian enterprise. Among the sectors featured, **precision manufacturing** emerged as a vital theme in shaping India's aspirations in high-tech and value-added production.

At the forefront of this conversation was **Ms. Smriti Sakhamuri**, Executive Director and Board Member of **HHV Advanced Technologies**, who participated as a panelist in the key session titled **"Innovation in Precision Manufacturing."** Her presence reinforced HHV's leadership position in a field that demands not only engineering excellence but also strategic foresight.

Sharing the stage with **Rajanikanth Balaraman**, Co-founder and CTO at Unimech Aerospace and Manufacturing Ltd., and **Gurushankara KC**, CEO and Co-founder of DHEYA Technologies, Ms. Sakhamuri contributed meaningfully to a dialogue that spanned **cutting-edge manufacturing technologies**, **start-up collaboration**, and **future talent pipelines**. The session was adeptly moderated by **Abhishek Chandra** of Evolvence.

In her remarks, Ms. Sakhamuri emphasized:

- The need for **deep integration of digital and precision processes**
- How **R&D-backed manufacturing** is central to global competitiveness
- The importance of **cross-sector partnerships** to accelerate innovation
- HHV's experience in translating **visionary concepts into industrial solutions** in domains such as thin films, photonics, and vacuum systems

Her perspective was firmly grounded in HHV's ongoing commitment to fostering India's **Make in India** and **Atmanirbhar Bharat** goals, and her contributions highlighted the Group's ability to combine legacy expertise with agile, forward-looking innovation.

By participating in such high-impact platforms, **Ms. Smriti Sakhamuri continues to serve as a driving force behind HHV's engagement with India's evolving innovation ecosystem**, ensuring that precision manufacturing becomes not only a backbone of industry but also a springboard for global leadership.

HHVAT at Surya Drona Tech,
- SIDM, Dehradun

HHVAT's booth at SURYA DRONA TECH 2025 showcasing advanced optical systems for UAV and thermal imaging applications.

At SURYA DRONA TECH 2025, HHV Advanced Technologies highlighted its advanced solutions in drone and counter-drone technologies, reinforcing its growing presence in India's defense and aerospace landscape. Exhibiting at Stalls 21 & 22, HHV showcased a specialized portfolio featuring night imaging optics, self-heating structures, ZnS domes, ultra-low reflection lenses, and infrared optics tailored for UAV platforms and surveillance systems. With increased attention on unmanned aerial systems and precision defense tools, the event offered a powerful stage for HHV to demonstrate its commitment to enabling mission-critical applications through innovation in optical and material technologies.

HHVTT at Emerging Vistas in Chemical Engineering,
- VSSC, Trivandrum

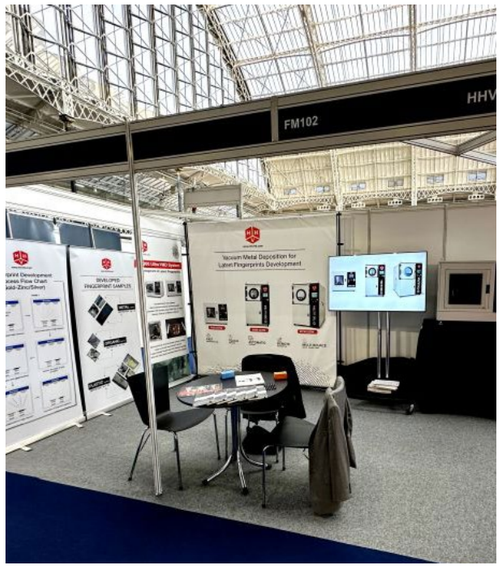
Showcasing carbon composites and stealth solutions for space and defense.

HHV TT Participated in the National conference on "Emerging Vistas in Chemical Engineering" 2025, held at VSSC, Trivandrum from May 16th and 17th, 2025. It Showcased its capability and facilities to undertake processing & manufacturing of carbon-carbon & carbon- ceramic composites and stealth pads for application in missile in and space components.

HHVAT at SVC TechCon 2025,
- Nashville, USA

HHV Advanced Technologies made a strong impact at SVC TechCon 2025, one of the foremost global gatherings for experts in vacuum coating and surface engineering. Exhibiting at Booth 205, HHV showcased its latest advancements in thin film deposition systems for applications across optics, electronics, automotive, and research sectors. The display featured innovations in thermal evaporation, sputtering, and plasma-enhanced CVD technologies, emphasizing both high-performance platforms and tailored solutions for R&D and production. Engaging with international researchers and industry leaders, HHV reinforced its position as a trusted global partner in advanced vacuum and coating technologies.

HHVAT at Forensics Europe Expo 2025,
- Olympia, London



HHV's cutting-edge forensic systems will be on display at the Forensics Europe Expo 2025, Booth FM102, Olympia London.

At the 2025 edition of Forensics Europe Expo in Olympia London, HHV Advanced Technologies highlighted its cutting-edge forensic capabilities with the flagship Forensic Ultra System at Booth FM102. Designed around Vacuum Metal Deposition (VMD) technology, the system delivers superior fingerprint development on non-porous surfaces such as plastic, glass, and metal — a method trusted by forensic professionals worldwide. With features like high-contrast imaging, robust reliability, and proven application in law enforcement, HHV reaffirmed its commitment to advancing the tools available for forensic science and crime scene investigation.

HHVAT at Laser World Of Photonics
- Munich, Germany

Team HHVAT at Laser World of Photonics 2025, Munich – Showcasing advanced optics and thin-film innovations to a global audience.

HHV Advanced Technologies took part in Laser World of Photonics 2025 in Munich, joining global leaders for four dynamic days dedicated to the latest in laser and photonics innovation. As a key exhibitor at Booth B1-244, HHVAT presented live demonstrations of advanced optics solutions, engaging with an international audience of researchers, collaborators, and technology enthusiasts. The event offered an exciting platform to showcase our capabilities, foster strategic connections, and reaffirm HHV's role in driving next-generation photonics and thin-film technologies.

HHVTT at ICEAMPS-2025,
- IIT, Hyderabad

Mr. Ummalaneni Raja Babu, DS & Director, RCI and Chief Guest at ICEAMPS-2025, visits the HHV Thermal Technologies booth at IIT Hyderabad.

HHV Thermal Technologies participated as a co-sponsor at the 1st International Conference and Exhibition on Advanced Materials and Structures (ICEAMPS-2025), held at IIT Hyderabad. The event, organized by ISAMPE Hyderabad Chapter in collaboration with the Advanced Systems Laboratory (DRDO) and IIT Hyderabad, brought together experts across academia, research, and industry. HHV TT showcased its capabilities at Booth Nos. 7, 8 & 9, with a spotlight on advanced carbon-carbon and carbon-ceramic composites used in aerospace and defense applications. Mr. P. Narendra Babu, COO – Carbon Composites Processing Division, delivered a technical session highlighting HHV TT's capabilities in processing and manufacturing of carbon-based composites and stealth technologies for missile and space systems. The visit of Shri Ummalaneni Raja Babu, DS & Director, RCI – and now Director General (Missiles & Strategic Systems), to our booth as Chief Guest underscored the strategic relevance of our offerings. The event served as a powerful platform to reinforce HHV's role in advancing indigenous materials and manufacturing excellence for national defense applications.

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