



DIRECTED VAPOR TECHNOLOGIES INTERNATIONAL

DVTI Leader in Production-Ready Coating Solutions

DIRECTEDVAPOR.COM

ABOUT DVTI

DVTI develops next generation advanced coatings. We are experts in the use of Directed Vapor Deposition (DVD), which allows rapid deposition of thin or thick films with highly controlled compositions and architectures onto both Line-of-Sight and Non-Line-of-Sight products. The result is a processing approach capable of fabricating more complex surface chemistries than conventional techniques, and creating coatings on surfaces too complex for conventional techniques.

DVTI utilizes the unique capabilities of the DVD process, our coating development expertise, and production coating service capabilities to create significant value for our customers through increased performance of their products, lower production cost, or a combination of both.

Our customers include both private industry and Government user facilities and program offices. Industry clients include major turbine engine manufacturers and large and small energy device companies, among others.



PRODUCTION COATING APPLICATION SERVICES

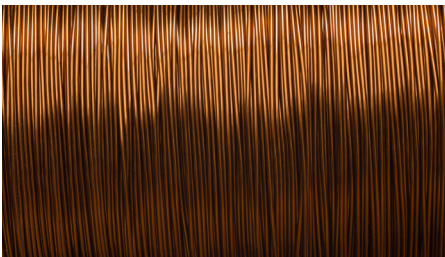
Our high-throughput capable DVD coating equipment is available for use in coating of products for you directly in our ISO 9001:2015 Certified coating facility, conveniently located in Charlottesville, Virginia. We also have a continuous reel-to-reel processing line for economically coating large quantities of flexible substrates such as fibers, yarns, and tapes with extremely well-adhered coatings for many unique applications.

COATING R&D SERVICES

DVTI delivers production-ready coating development services and coating application services to manufacturers and integrators. DVTI offers its customers the ability to transition innovative product improvements from idea to proof-of-concept and execute the solution in a production environment. With its team of researchers and engineers continuously engaged in the future needs of our customers, DVTI can provide integrated engineering and product development services for coating-enhanced components and devices. Our unique expertise and coating equipment allows us to prove customer specific coating concepts and then transition those concepts into regular production.

DVTI also uses DVD as a tool for quasi-combinatorial synthesis, an efficient approach to designing complex alloys from scratch. This technique overcomes the lack of data needed to identify new alloys, especially quaternary and high entropy alloy (HEA) systems useful in high temperature gas turbine engines and thermo-electric generators.

TYPES OF COATINGS



Fiber Coatings

The DVD process provides superior adhesion of coatings on fibers and allows us develop coating materials with additional beneficial properties in electrical conductivity and/ or electromagnetic shielding. This presents many opportunities for improvements in both commercial and military applications. Examples of capabilities include, but are not limited to:

Coating Materials: Copper, Silver, Nickel, Aluminum, Gold, Magnesium, and/or Tin.

Coated Monofilaments, Tows, Yarns, and Tapes: Aramid (Kevlar®), PBO (Zylon®), PEEK, E-Glass, PTFE, Carbon Fiber, and Carbon Nanotubes.



Corrosion and Wear Protection

DVTI has demonstrated aluminum and aluminum alloy coatings applied by DVD that have excellent corrosion resistance (>1,000 hours in scribed salt fog testing). The unique wear coatings have shown to be better than chrome coatings – three to five-fold reduction in wear rate, three times harder, and 40 times the hardness to elasticity ratio. The deposition process does NOT create hazardous waste (offers alternatives to hazardous Cadmium and Hard Chrome). The coatings do NOT require post-coating treatment. Processing these coatings by DVD has the additional benefit of being able to easily coat non-line-of-sight regions of components, such as the interior walls of tubes.



Thermal Barrier Coatings (TBC)

A variety of TBC systems have been developed for use in aerospace and industrial gas turbine engines requiring resistance to high temperatures and lengthy exposure times, using the DVD process to deposit bond and top coat layers. DVTI is continuing to develop novel coating materials and structures, both of which are imparting improved properties using the unique coating composition and morphology control provided by DVD. Industry standard bond coat (e.g., MCrAlY) and top coat (e.g., YSZ) compositions can also be enhanced by the attributes of the DVD process to produce well-adhered coatings to components in both line-of-sight and non-line-of-sight regions.

OTHER COATINGS INCLUDE		
Oxidation and Hot Corrosion	Environmental Barrier for Ceramic Matrix Composites	
Metal Alloy Development	Antimicrobial and Bio-Compatible	Advanced Battery Materials



Application Areas



Gas Turbine Engines

DVTI has extensive expertise in developing unique solutions to turbine engine needs including customized top coats and bond coats to improve protection against wear, erosion, and molten sand and increase thermal resistance. These improvements translate into increased reliability and durability of the coating, increased fuel efficiency and engine performance, and increased part life that equates to decreased maintenance time and expense. Accustomed to working with nickel super alloys and ceramic matrix composites (CMCs), alike, DVTI is capable of processing a wide range of metallic and ceramic compounds. The ability to apply materials via multisource evaporation has led to a number of unique hot corrosion and oxidation resistant coatings and environmental barrier coatings (EBCs).

Lightweight Conductive Fibers

Modern commercial aircraft range between roughly 70 and 300 miles of wiring, with Boeing's 787 at approximately 70 miles and Airbus' A380 at nearly 330 miles. Since a large portion of the weight of an aircraft's electrical power system is due to wiring, there is a significant opportunity for higher performing wires and cables to greatly reduce overall weight and improve efficiency in modern aircraft, which rely heavily on electrical components and systems. This translates to cost savings for operators, who save 0.75% in fuel consumption for every 1% in reduced weight. Other uses of conductive fibers include improved composites used in electromagnetic interference (EMI) shielding and lightning strike protection.

Aviation Components

DVTI has demonstrated wear and corrosion resistant coatings that are especially applicable to components of aircraft landing gear systems, where both the internal and external surfaces of a component may need coating. These coatings were developed as non-toxic replacements to the commonly used hard chrome and cadmium coatings. The unique compositions also have the ability to significantly increase wear protection, thereby extending the life of valuable components. As a replacement to processing chrome-replacement coatings by ion vapor deposition (IVD), DVD offers several advantages including the elimination of post-coating densification treatments. DVTI's pure aluminum corrosion resistant coating conforms to MIL-DTL-83488D specification. Aluminum alloy coatings are also available, as may be determined by the needs of the application.



Automotive Racing

Heat, wear, corrosion, and friction all aim to reduce engine performance and reduce component lifetimes, leading to in-service failures. DVTI is adapting coatings and processing techniques originally developed for turbine engine applications to meet the unique needs of automotive racing. Cooling needs can be managed with the use of thermal barrier coatings, even within the winding passages of exhaust ports. Surface modifications tailored to the engine alloy and operating environment provide protection from exhaust byproducts and other potentially corrosive elements. Tribological coatings can greatly reduce the effects of friction and wear on high-cycle moving components and minimize damage from oil-out conditions.



Smart Fabrics/E-textiles

DVD has proven to be effective at depositing well-adhered materials at high rates onto flexible polymer, carbon, and carbon nanotube products. This allows for the creation of lightweight, flex-tolerant tapes, yarns, and wires possessing functions such as electrical conduction and supercapacitance for use in smart fabrics where electronics such as sensors, controls, energy harvesting, and other smart features continue to be incorporated into textile products. Additionally, concepts for producing conformal batteries utilizing DVD processed textiles will have many commercial applications, with the emergence of wearable technologies that require lightweight, flexible energy storage solutions.



Advanced Energy Storage Materials

DVTI is utilizing the high rate, vapor phase processing capabilities of DVD to improve components found in lithium-based batteries and, more broadly, to develop solutions needed for the creation of next generation, higher energy density solid-state batteries. Among the areas of application for this processing technique is the creation of ultra-thin polymer ceramic composite (UTPCC) materials for a variety of battery chemistries including lithium-ion, lithium-sulfur, and lithium-air. High rate deposition of lithium electrolytes (e.g., LiPON) have also been demonstrated using DVD. The ability of DVD to deposit energy storage materials onto flexible substrates could further advance battery technology, leading to reel-to-reel manufacturing of several new concepts.

DIRECTED VAPOR DEPOSITION EXPERTS



DVD precisely controls the transport of vapor atoms from the source to the target product with minimal waste. A trans-sonic gas jet directs a thermally evaporated vapor cloud onto a component, lending itself to high deposition rates and non-line-of-sight (NLOS) coating. Key advantages include:

- » **Non-Line-of-Sight (NLOS) Deposition:** producing similar coating thickness and other properties to line-of-sight coated areas without significant part manipulation.
- » **Multiple Source Evaporation:** permitting complex chemistries and/or multi-layered coatings to be deposited in a single step.
- » **High Deposition Rate:** allowing precise composition control while maintaining deposition rates in excess of 10 μm per minute.
- » **Lower Cost:** achieving faster production rates, higher materials utilization, and increased life span of advanced coatings to reduce costs for our customers.
- » **Plasma Activation:** enabling hollow cathode plasma activation to increase coating density when desired.

KEY PERSONNEL



Mr. Harry Burns
President & CEO

Mr. Burns leads the industry-experienced team of manufacturing executives and technologists at DVTI. During his more than 30 years of corporate experience, he has served in a number of senior executive capacities including as CEO of an international manufacturing and marketing company with more than 2,200 employees, nine major production sites, and annual revenues in excess of \$500M. Mr. Burns is also experienced with the start-up of new technology companies and the commercialization of new technologies, having led other early-stage ventures that resulted from academic research. Mr. Burns holds a J.D. degree from Emory University and has participated in INSEAD's Advanced Management Program.



Mr. James Maurer
Vice President of Business Development

Mr. Maurer joined DVTI with more than 20 years of executive management experience at HDT Global, a defense equipment company with more than \$500 million in annual sales. Throughout his career, he has managed several functional areas of business, including operations, marketing and sales, engineering, and corporate development. Mr. Maurer leads the technology transition and quality management programs at DVTI.



Dr. Derek Hass
Vice President of R&D & CTO

Dr. Hass received a B.Sc. in Metallurgical Engineering from Michigan Technological University in 1993. He earned a M.S. degree from the University of Virginia in 1996 and a Ph.D. degree in 2001. His research interests include the application of the DVD technology to thermal barrier coatings for turbine blades, coatings for wear and corrosion abatement, bonding layers for solid oxide fuel cells, thin film batteries, superconducting coatings, and high-temperature alignment layers of liquid crystal displays. Dr. Hass oversees DVD technology development for a variety of research and commercial applications.



Dr. Balvinder Gogia
Research Scientist

Dr. Gogia earned her B.S. and M.S. in Physics from Panjab University (Chandigarh, India) and Ph.D. in Physics and Material Science from the Indian Institute of Technology. She has more than 20 years of industry and research experience in the fields of thin film deposition and nanotechnology and leads several technology development teams in Non-Line-Of-Sight coating and superconducting films at DVTI. Dr. Gogia is active in the use of DVD for environmental barrier coatings on ceramic matrix composite turbine engine components.

IF YOU HAVE A PRODUCT OR TECHNOLOGY
YOU THINK MAY BENEFIT FROM OUR COATING
SERVICES, PLEASE CONTACT US

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