COATING TECHNOLOGY FOR THE FUTURE

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OUR VISION

To develop and apply the next generation of advanced coatings. Directed Vapor Deposition (DVD) can rapidly deposit thin or thick films with highly controlled compositions and architectures onto both Line-of-Sight and Non-Line-of-Sight items. The result is a processing approach that creates more complex surface coatings than conventional techniques, and does so on surfaces too complex for conventional techniques.

OUR OBJECTIVE

To utilize the unique capabilities of the DVD process to create significant value for our customers through increased performance of their products, lower production cost or a combination of both.

OUR TECHNOLOGY

Production Scale Capabilities DVTI has recently built DVD III, a fully operational production capable coater. This invaluable addition allows us to prove customer specific coating concepts and then transition those concepts into regular production. Careful design of the coating chamber grants us the flexibility to accommodate specialty objects and high throughput production lines with minor reconfiguration.

In the DVD coater, source materials are converted to vapor by a 60 kW electron-beam gun, which is capable of simultaneously evaporative multiple sources. The high, 75 kV operating voltage allows the beam to work in soft vacuum pressures, further increasing deposition parameter space and reducing chamber pump-down time. The fully computer controlled operation allows for repeatable deposition campaigns and a low cost per run.

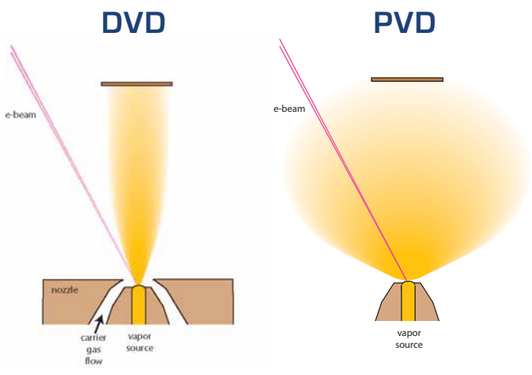
In addition, the company has an on-going arrangement with the University of Virginia to access its two, smaller coaters for research and development.

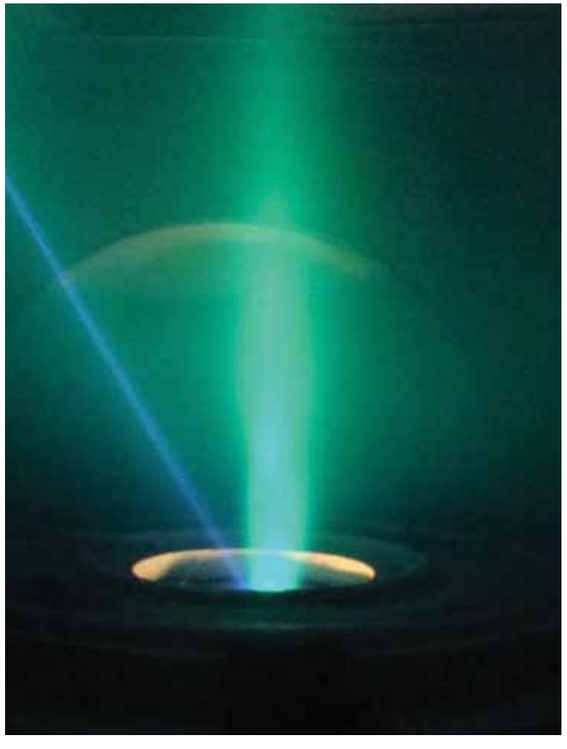
OUR EXPERTISE

The technology that is DVTI's core competency – Directed Vapor Deposition (DVD) – originates in research conducted at the University of Virginia. Through, a licensing agreement with the University of Virginia Patent Foundation, DVTI holds a worldwide license to this technology.

DVD VS PVD

The DVD approach (left) directs the evaporants onto a substrate, allowing high deposition rates, NLOS application and less material waste than the PVD approach (right), which simply creates an undirected cloud of evaporant that coats unevenly and deposits most of the material on the chamber walls.





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HOW IT WORKS

DVD is an advanced approach for vapor depositing high quality coatings. This process is capable of depositing compositionally controlled dense or porous coatings onto Line-of-Sight and Non-Line-Of-Sight (NLOS) regions of complex components. Unlike other Physical Vapor Deposition (PVD) approaches, DVD precisely controls the transport of vapor atoms from the source to a substrate. To achieve this, DVTI utilizes a trans-sonic gas jet to direct a thermally evaporated vapor cloud onto a component.

Also unique to the DVD process is the use of a "soft" vacuum, which requires only simple mechanical pumping and results in short (several minutes) chamber pump-down times. In this regime, collisions between the vapor atoms and the gas jet create an ideal mechanism for controlling the vapor transport. These conditions enable several exclusive advantages.

OUR ADVANTAGES

DVTI offers coating development services with a unique process that can be transitioned to the plant floor. Our highly experienced scientific and engineering team constantly works with customers to develop and apply unique coating compositions that push the limits of the science. The DVD process has many advantages over other coating technologies, such as:

- Non Line of Sight Deposition: A unique feature of DVD no traditional technology can offer. Unlike other vacuum deposition technologies, the high pressure gas jet carries vapor atoms into internal regions of components and then scatters them onto those surfaces, resulting in NLOS deposition with similar properties to the line-of-sight areas.

- Multiple Source Evaporation: Another unique feature that no other methods permit is the use of many evaporation sources. This allows the creation of alloys with precise compositional control as well as permitting complex, multi-layered coatings to be deposited in a single step.

- High Deposition Rate: Vapor phase collisions between the gas jet and vapor atoms allow the flux to be "directed" onto a substrate which equates to precise control at very high deposition rates (> 10 μm min^{-1}).

- Minimal Waste: DVD has a very high Materials Utilization Efficiency, meaning it applies most of the evaporated material onto the desired substrate and not onto the chamber walls, a problem with previous technologies.

- Plasma Activation: DVTI has added further versatility by incorporating hollow cathode plasma activation. This capability can be used to increase the density of DVD layers as desired.

- "Soft" Vacuum Chamber: Unlike earlier technologies, DVD requires only a "soft" vacuum, allowing for chamber pump-down times of a few minutes rather than the few hours needed for conventional techniques. This translates directly into faster production rates.

- Lower Cost: Faster production rates, less wasted material, and increased life span of advanced coatings reduce coating costs to our customers.

THE APPLICATIONS

At DVTI, we see exciting possibilities for our coating technology everywhere and are always investigating new ways that we can make a difference. Areas of current research and development are:

Gas Turbine Engines: DVTI has extensive expertise in developing unique solutions to turbine engine needs. R&D projects for the "hot" section of the engine include tailored top coats and bond coats that are compatible with new and future generations of superalloys and ceramics and that 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. Ongoing projects specifically address:

- Thermal Barrier Coating (TBCs)
- Environmental Barrier Coatings (EBCs)
- CMAS Protective Coatings
- Oxidation and Hot Corrosion Resistant Coatings

Aviation: DVTI has created compositions that significantly increase wear protection, thereby extending the life of valuable components. We have also developed an environmentally friendly replacement to the toxic hard chrome and cadmium coatings commonly in use today. The constant battle against corrosion costs the government and industry billions each year, a battle we are ideally equipped to help wage.

- Wear Resistant Coatings
- Hard Chrome and Cadmium Replacement Coatings
- Corrosion Resistant Coatings

Thin Film Lithium Ion Batteries: DVTI is also active in the development of energy storage devices, where the DVD process offers the ability to create solid state batteries more quickly and economically than conventional methods. DVD achieves the unique combination of high deposition rates and high coating quality, which is both compositionally and microstructurally controlled. The non-line-of-sight deposition capabilities of DVD also enable its use with advanced 3D battery structures. Recent work has created thin LiPON electrolytes with good ionic conductivities at deposition rates more than 40 times faster than those of conventional coating processes.

Other Areas of Development

- Solid Oxide Fuel Cells
- Superconductors
- Medical Devices
- Optical Coatings
- Nanowire Sensor Elements

KEY PERSONNEL

Mr. Harry Burns, President & CEO

Mr. Burns has over 30 years of experience as a senior executive in industry. He has served as CEO of an international manufacturing company with revenues in excess of $500 million and is experienced with the start-up of new technology companies and the commercialization of new technologies.

Dr. Derek Hass, Dir of Research and Development

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 onto turbine blades, coating for wear and corrosion, bonding layers for solid oxide fuel cells, thin film batteries, superconducting coatings, and high-temperature alignment layers of liquid crystal displays.

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. Susie Eustis, Research Scientist

Dr. Eustis received a B.Sc. in Chemistry from Rochester Institute of Technology in 2000 and a Ph. D. in Physical Chemistry from Georgia Institute of Technology in 2006, specializing in nanotechnology. From 2006 to 2008, she was a National Research Council (NRC) postdoctoral fellow at the National Institute of Standards and Technology (NIST). Her research interests include nanostructured particles and thin film applications in medicine, optical components, and energy devices. Dr. Eustis leads DVD technology development for a variety of commercial applications.

CUSTOMERS

DVTI's 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.

RECENT PROJECTS

Government

- Non-Line-of-Sight Coating of Turbine Airfoils, U.S. Navy
- High Temperature Coatings for Turbine Blades & Vanes, U.S. Navy
- Thermal Barrier Coating Environmental Durability Enhancement (CMAS), U.S. Navy
- Multi-functional Erosion Resistant Coatings for Turbine Engine Components, U.S. Army
- Wear Resistant Coatings for Aircraft Structures, U.S. Air Force
- Surface Processing for Enhanced Environmental and Creep-Fatigue Resistance, U.S. Air Force
- High Rate Deposition of Epitaxial Films for Use in Superconducting Coated Conductors, DOE
- Deposition Technology for Thermal Barrier Coatings with Increased Toughness, NSF

Private (company names withheld)

- Coatings of High and Low Pressure Turbine Blades and Vanes
- Coil Electrode Coatings for Medical Devices
- Conductive Coatings for Disposable Batteries
- Cadmium Replacement Coatings
- and more…

WORKING WITH DVTI

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. Using its full-scale coating facility, DVTI delivers production-ready coating development services and coating application services to Original Equipment Manufacturers.

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

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