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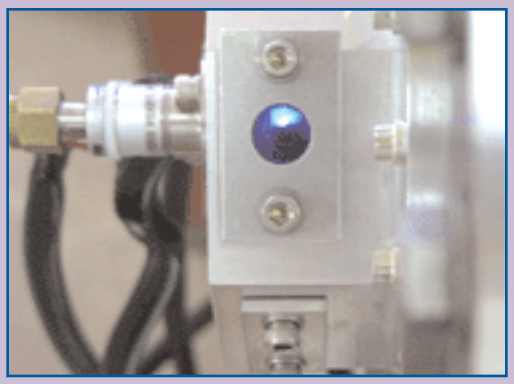
ADVANCED MATERIALS

PULSED LASER DEPOSITION PROCESS PRODUCES HIGH-QUALITY THIN FILMS AT HIGH RATES

In a related BMDO-funded project, AMBP Tech demonstrated the viability of a pulsed-arc technique similar to its laser-assisted deposition process.

Those in pursuit of high-quality thin films face a dilemma when choosing a fabrication method. Chemical vapor deposition (CVD) offers high deposition rates, but often requires expensive precursors, uses high temperatures, and produces undesirable byproducts. Physical vapor deposition (PVD) is much cleaner, yet deposition rates are typically lower than for CVD. Also, many materials, such as oxides, cannot be efficiently deposited using PVD methods.

With BMDO SBIR funding, AMBP Tech Corporation (Amherst, NY) has developed another option: laser-assisted molecular-beam deposition (LAMBD). This method can be used to create uniform, high-purity thin films from 50 angstroms to 10 microns with very flat morphologies.



Plasma portal. *Through a small window in the deposition tool, operators can view the plasma plume created by the laser ablation pulse focused down on a target metal surface.*

LAMBD is a reactive process that simplifies the production of complex films such as carbides, nitrides, and metal alloys. These films have many applications in the microelectronics industry, including metal-oxide films and silicon-on-insulator (SOI) devices, which are needed for next-generation electronics. In particular, SOI technology offers many advantages for BMDO applications, such as high speed, low voltage/power, radiation tolerance, and high-temperature operation. In addition, LAMBD can be used to create buffer layers for superconducting tape, an emerging technology with many electric power applications.

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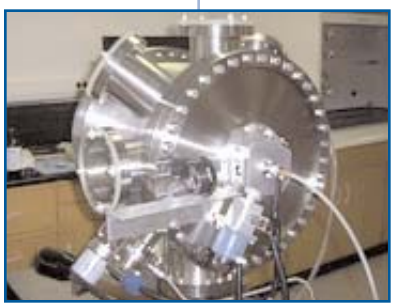
Pulsed Laser . . . from page 1

Similar to pulsed laser deposition, the LAMBD source uses a laser to rapidly heat a target causing a cloud of evaporated target material to be generated. This cloud is simultaneously combined with a pulse of reactant gas, often oxygen or nitrogen. The ablated target material and the gas form a unique chemical reactor from which nanoparticles can be generated or from which films can be deposited. For example, a titanium or gallium target rod can be used along with nitrogen to create titanium nitride or gallium nitride films.



Save $20 million. *The LAMBD source is adaptable and can be used alone or in tandem with existing deposition equipment.*

The product molecules are expelled from the pressurized LAMBD source into a vacuum chamber, where they are deposited on the substrate. With each pulse, a known amount of material is deposited. By adjusting the laser power, the amount of material deposited by each pulse can be varied, while regulating the total number of pulses used in the deposition process allows precise control of film thickness. Typical deposition rates are on the order of hundreds of angstroms per minute.

Because the product materials are accelerated toward the substrate only by the pressure difference between the LAMBD source and the deposition chamber, their kinetic energy levels are low, reducing the potential for substrate damage. Additionally, the ability to focus the laser beam only on the target material results in very low levels of contamination.

A prototype system with a 3-inch wafer capability has been developed. Work has begun on finding ways to spread material over larger areas, with the goal being first 8-inch and then 12-inch wafers. In the meantime, AMBP Tech would like to license the technology while making films, coatings, and nanoparticles as a service. To further commercialization efforts, the company seeks additional partners, personnel, and funding.

—P. Hartary

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