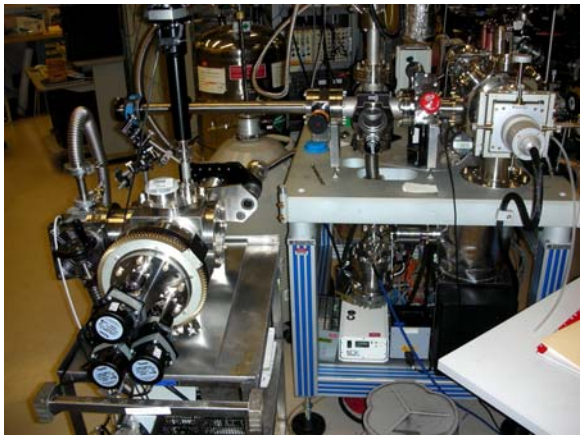
Lab on the run

Investment in staff research enables new surface science capability at EMSL

Internal staff investment via the Intramural Research Program at the Department of Energy's EMSL has resulted in a new capability now available to EMSL users, called PMLD. Standing for pulsed multiple laser deposition, PMLD builds upon traditional pulsed laser deposition—a versatile instrument by which a target material is ablated by a laser, creating a plume of vaporized particles that are deposited as a thin film on a substrate. Developed by EMSL Senior Research Scientist Ken Beck, PMLD gives EMSL users the ability to synthesize novel materials, such as nanocatalysts and sensors, opening new doors in surface science research and discovery.



PMLD unit (left) aligned with EMSL's photoemission electron microscope. PMLD's design allows it to replace the photoemission electron microscope loadlock chamber for in vacuo sample preparation.

The PMLD unit is mobile, compact, flexible, and capable of interfacing with a variety of laser systems and surface analytical instrumentation available to EMSL users. Moreover, it features a self-contained, ultrahigh vacuum pumping system, substrate heating unit, and optical bench. The PMLD enables five different deposition techniques new to EMSL: (1) traditional pulsed laser deposition with a selection of laser sources, (2) multi-target combinatorial material exploration, (3) laser back ablation, (4) multi-laser pulsed laser deposition for tailored film and phase deposition, and (5) reactive ballistic pulsed laser deposition for high-surface-area nanoarchitectures. These techniques reduce waste in addition to enabling new research. For example, during laser back ablation, the beam interacts with the target from the "back side," resulting in less waste of the starting target material and faster deposition rates. Multi-laser pulsed laser deposition enables one laser to ablate and a second laser to further ionize and heat the plume so the temperature of the deposited material, and potentially its phase, can be changed. Using reactive ballistic pulsed laser deposition, scientists can synthesize crystalline, nanostructured metal oxide thin films made from refactory grade metals, or other high-temperature materials with high surface area.

Scientific impact: PMLD supports EMSL's goal to design and synthesize increasingly complex materials, allowing EMSL users to produce novel surfaces that apply to research in all of EMSL's Science Themes. In particular, PMLD will enhance research and development of electronic and optical materials.

Societal impact: PMLD affords researchers the ability to synthesize novel materials such as nanocatalysts, sensors, and "smart" metal alloys. The flexibility of this new tool may lead to the discovery of optimal structures and functionalities for the improved efficiency, safety, and reliability of processes and products – for example, optimized efficiency of transport vehicles. In addition, techniques used in PMLD promote the efficient use and reuse of materials that can make a major contribution to a sustainable society.