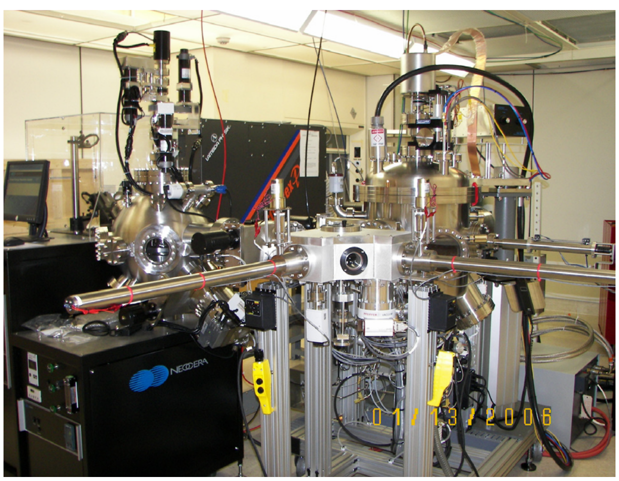
Combinatorial Measurements of Inorganic Thin Films

Facilities

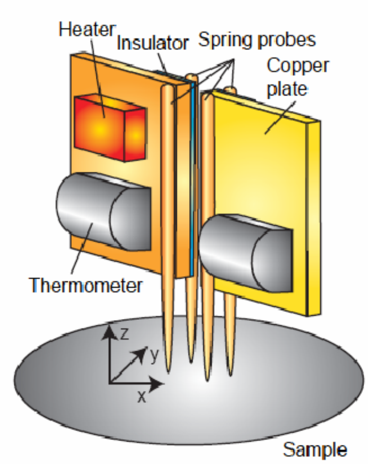
MSEL researchers have established a combinatorial measurement facility for inorganic materials, enabling high-throughput experiments using automated measurement methods. A custom-built combinatorial thin film synthesis tool has been developed for depositing thin film "libraries", which contain a variation of a film parameter of interest, *e.g.*, composition, growth temperature, or film thickness. Libraries can be grown by either sputtering (best for metals, simple oxides and nitrides), or by pulsed laser deposition (PLD, best for complex oxides and multicomponent materials). Measurement of the desired proper-ties of film libraries must also be rapid, *i.e.*, combinatorially-friendly. The following suite of high-throughput structure or property mapping tools are in use or under development: (1) spectroscopic reflectometry for film thickness; (2) wavelength dispersive spectroscopy for film composition; (3) scanning tool for Seebeck coefficient of thermoelectric materials; (4) automated capacitance-voltage probe station for work function; (5) nanocalorimetry based on dense arrays of microelectromechanical systems for film thermal stability; and (6) micro x-ray diffraction for crystal structure.



Thin film combinatorial library synthesis tool, showing sputtering (back right) and PLD (left) chambers

Significance

Combinatorial materials science is a rapid experimental methodology characterized by high through-put parallel experiments, automated measurements, and massive data sets. It has become a new paradigm to accelerate the identification and development of inorganic materials such as transparent magnetic films, ferroelectrics, and magnetic semiconductors for advanced device applications. MSEL pursues active combinatorial programs in novel high dielectric constant and metal electrode layer materials for complementary-metal-oxide-semiconductor advanced gate stacks, as well as thermoelectric materials for waste heat recovery and solid-state refrigeration applications. The goal of this work is to provide combinatorial methods and data that can be used to decrease the time for commercial implementation of such novel materials.



Schematic diagram of scanning Seebeck coefficient measurement tool designed and built in MSEL.

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