

Accelerate Materials Innovation with Intermolecular's High-Throughput Experimentation

Developing and manufacturing complex materials can be difficult and timely.

Challenges include:

- Quickly selecting and optimizing materials from a complex range of options
- Dealing with potentially toxic materials within a fab environment
- Experimenting to find efficient and high quality data discovery process

Intermolecular's High-Throughput Experimentation (HTE) platform enables a different way to discover new materials, one that is compatible with semiconductor manufacturing processes, and delivers a high volume of materials data. Unlike doing experiments in a conventional wafer fab which is limited in options, Intermolecular's processes are based on a high number of experiments in a short period, enabling a wide range of materials or conditions to be studied quickly.

INTERMOLECULAR'S APPROACH TO MATERIALS INNOVATION IS FASTER, LESS COSTLY, YIELDING SUPERIOR RESULTS THAN CONVENTIONAL METHODS

CONVENTIONAL

OPTIMIZED FOR **MANUFACTURING**



| | | |
|----------------------------|---------|---|
| Experiments Per Wafer | ONE | ✗ |
| Experimental Efficiency | LIMITED | ✗ |
| Material & Process Options | FEW | ✗ |

ONE 300 MM WAFER YIELDS **1 EXPERIMENT**

INTERMOLECULAR®

OPTIMIZED FOR **MATERIAL UNDERSTANDING**



| | | |
|----------------------------|--------|---|
| Experiments Per Wafer | 10-100 | ✓ |
| Experimental Efficiency | HIGH | ✓ |
| Material & Process Options | MANY | ✓ |

ONE 300 MM WAFER YIELDS **30 EXPERIMENTS**

Finding the Right Materials for Memory Selectors using PVD Chalcogenides

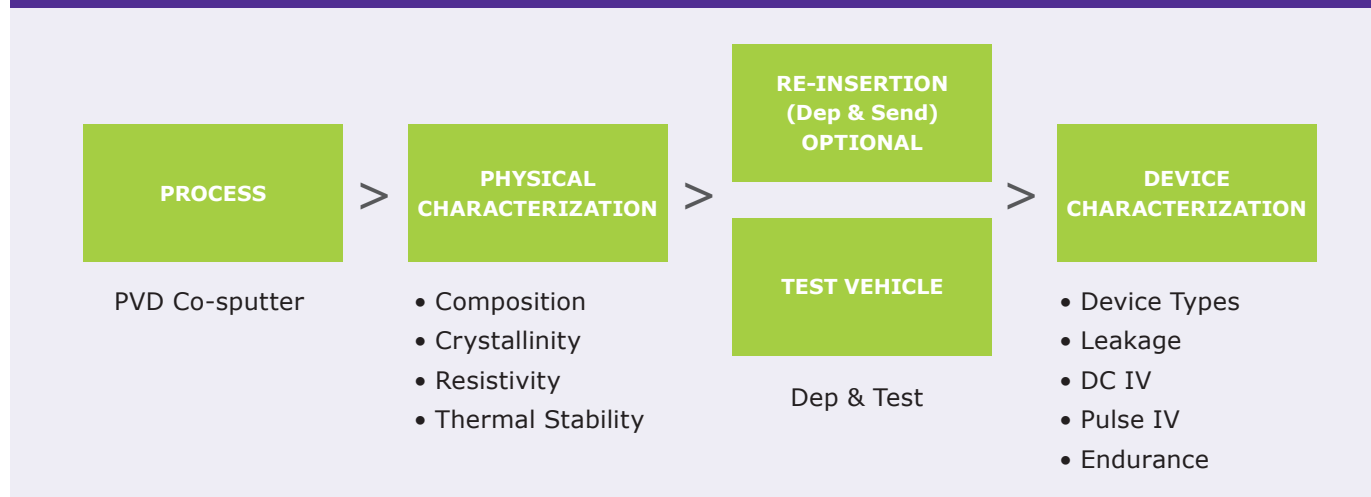
The rapid move towards next-generation non-volatile memories (NVM) in 3D Crosspoint architectures has created a critical need for current steering devices or selectors. Chalcogenides are promising selector materials but the specific elements and composition spaces showing selector behavior per specific key performance metrics is not well known. Using Intermolecular's High-Throughput Experimentation platform, combined with our extensive know-how and experience with advanced memories and chalcogenides, we can dramatically speed the discovery and reliable characterization of these challenging materials compositions for emerging NVM devices.

Intermolecular E-test device is available for rapid evaluation of selector and NVM performance. Device geometries from 1um to 200nm with on-chip variable series load resistors and minimal parasitic capacitance

Specific Services for NVM:

- Screen and optimize metal-oxide, MIEC, or OTS (phase-change) material systems for non-volatile memory
- Physical Vapor Deposition (PVD) based evaluation of multinary materials (→5 elements) and metal/metal nitride electrodes
- PVD co-sputtering with multiple, composite PVD targets
- Extensive physical and electrical characterization

FINDING THE RIGHT MATERIALS FOR MEMORY SELECTORS USING PVD CHALCOGENIDES



INTERMOLECULAR'S EXPERIENCE IN SCREENING NEW SELECTOR MATERIALS



| | |
|------------------------|-------------------|
| Metal Chalcogenide | 2500+ experiments |
| MIEC | 2000+ experiments |
| Transition Metal Oxide | 1000+ experiments |

INTERMOLECULAR[®]

3011 North 1st Street, San Jose, CA 95134
www.intermolecular.com

Intermolecular is a subsidiary of Merck KGaA, Darmstadt, Germany

