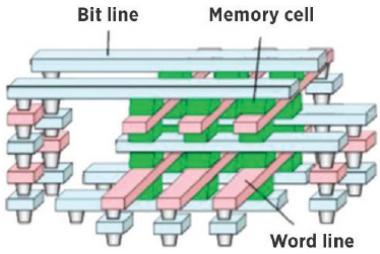
INTERMOLECULAR®

EMD ELECTRONICS

Accelerated ALD Process Development of Chalcogenide Materials For NVM

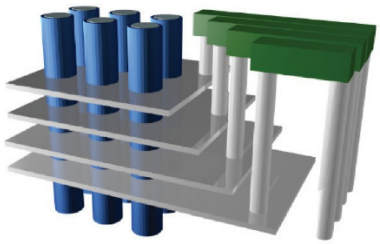
Pathways to 3D Crosspoint Arrays

TRADITIONAL 3D CROSSPOINT: HORIZONTAL CROSSBAR ARRAYS



- Patterning intensive
- Expensive integration
- Possible to realize utilizing all PVD approach

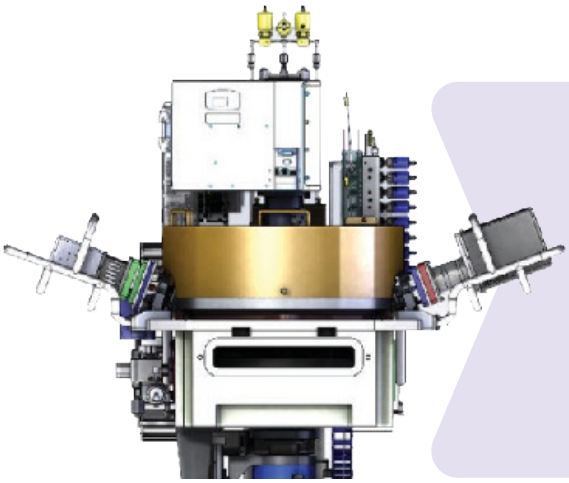
VERTICALLY INTEGRATED 3D CROSSPOINT



- Fewer mask steps
- Less expensive integration
- Requires 3D deposition of active layers
- ALD Development needed to realize the benefits of this architecture

Non-volatile memory (NVM) technologies such as resistive random access memory (RRAM) or phase change memory (PCM) has shown the potential in next generation data storage applications. In these applications, NVM devices need to be packed densely in cross-bar memory arrays that require a selector device, such as the ovonic threshold switch (OTS) in series with the memory element to minimize parasitic currents in the array.

The NVM architecture must also be of a high areal density, making three dimensional (3D) integration of both the memory and selector active layers attractive. To obtain this in a cost competitive fashion, vertically integrated crosspoint structures are of particular interest. To realize vertically integrated 3D crosspoint memory, there is a need for the development of atomic layer deposition (ALD) processes for the materials used in both the memory and selector elements deployed in these memory arrays.



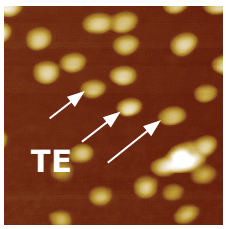
- Intermolecular has leveraged its accelerated development platform to rapidly develop a conformal elemental Te ALD process
- Elemental Te can be used to tune the composition in various OTS pertinent films, such as the GeTex, where the OTS behavior is known to outside of the GeTe and $GeTe_2$ compositions typically obtained in binary ALD alone
- Using in-situ diagnostics, appropriate precursor systems can be identified and nucleation challenges overcome

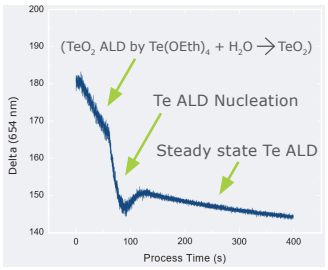
Enabling of ALD Chalcogenide Thin Films

Elemental Te ALD: $((CH_3)_3Si)_2Te+Te(OEth)_4 \longrightarrow Te$

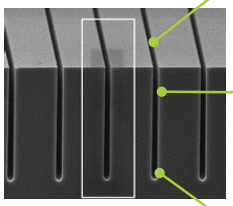
NUCLEATION BEHAVOIR

Deposition on native oxide terminated Si leads to island growth





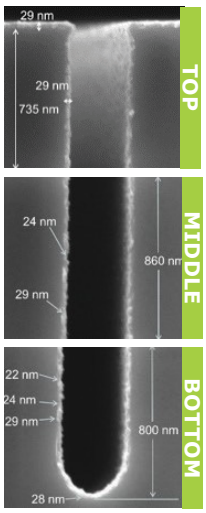
In-situ SE leveraged to rapidly identify suitable nucleation layer



- ~1 Å/cycle
- 250nm, 24:1

AR trench structures

CONFORMALITY



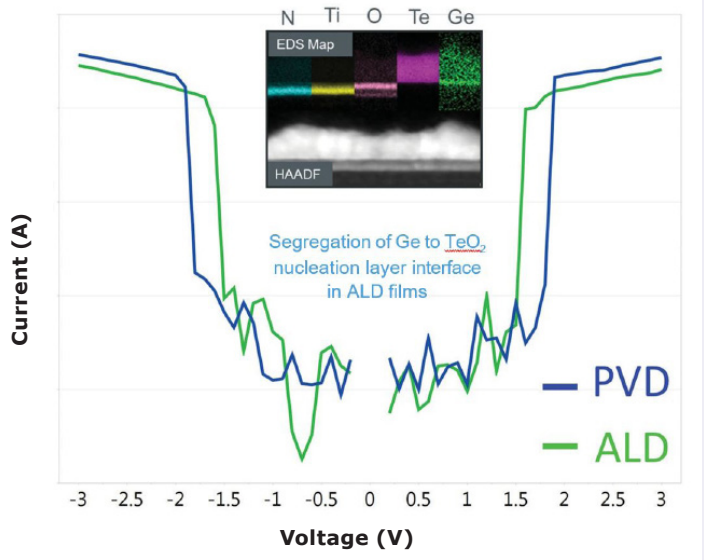
Utilizing Intermolecular's materials innovation platform, a suitable nucleation layer was identified and deployed to release continuous, conformal coatings of elemental Te on high aspect ratio test structures.

Integration of Te With $GeTe_2$ Process

SUPERCYCLE STRUCTURE

3X $[Ge(OEth)_4+((CH_3)_3Si)_2Te \longrightarrow GeTe_2]$ (ref 1)

1x $[((CH_3)_3Si)_2Te+Te(OEth)_4 \longrightarrow Te]$



Although compositionally segregated, ALD deposited $GeTe_x$ thin films exhibit similar PIV switching characteristics to films deposited by homogenous PVD $GeTe_x$ of similar composition.

(Ref. 1) Eom et al. Chem. Mater. 24 2099 (2012)

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