Advanced Microelectronic Materials and Devices Mini-Symposium
Room 318 - Session AM1+EM+TF-WeA

Industry Perspective

Moderators: Robert Grubbs, IMEC Belgium, **Sarah Lynch**, TEL Technology Center, America, LLC, USA

2:15pm **AM1+EM+TF-WeA-1 Memory Centric AI and the Role of Advanced Materials in Future Semiconductor Technologies***, **Shivani Srivastava,*** Micron Technology **INVITED**

The rapid growth of artificial intelligence (AI) is shifting system design from compute-centric to memory-centric architectures, where bandwidth, capacity, and energy efficiency increasingly determine performance. For AI workloads, the resulting memory bottleneck is creating new demands on semiconductor materials, processes, and integration schemes.

This talk will examine how these demands are influencing the future direction of advanced DRAM, High Bandwidth Memory (HBM), 3D and emerging nonvolatile memory technologies.

In DRAM, continued scalingis increasingly associated with efforts toward leakage reductions, variability minimization, and the exploration of novel integration schemes to optimize performance.

In parallel, industry trends toward increasing 3D DRAM layer counts are driving the need for high aspect-ratio etch and gap fill, conformal deposition, and high-quality epitaxial growth approaches.

While HBM, advanced CMOS integration, and heterogeneous packaging are becoming essential to reducing the compute-memory gap, thermal-mechanical reliability, power efficiency, and co-packaged optics are expected to play an increasing role in improving system-level performance.

Across these platforms, thin-film process control, conformality, interfaces, defect management, thermal-mechanical reliability, and system-level co-optimization are emerging as central levers for overcoming the AI memory wall.

2:45pm **AM1+EM+TF-WeA-3 Epitaxial CVD Ruthenium for High-Performance Interconnects at A7 and Beyond***, **Gyana Pattanaik,*** Tokyo Electron America*; Jean-Philippe Soulié, Christoph Adelmann, Nicolas Jourdan,* IMEC, Leuven, Belgium*; Kai-Hung Yu,* Tokyo Electron America R&D*; Tadahiro Ishizaka,* Tokyo Electron Technology Solutions (TTS), Belgium*; Hidenao Suzuki, Cory Wajda,* Tokyo Electron America R&D

Ruthenium is projected to replace Cu in A7 node or beyond, likely bringing back subtractive integration that Cu replaced with damascene almost 3 decades ago. To enable this transition, integration of Ru interconnect metal lines and vias with lower resistivity need to be demonstrated. Ru thin films with very low resistivity (~8 μΩ-cm at 30nm; bulk =7.4 μΩ-cm) has been reported [1], by depositing epitaxial PVD Ru on Si (111) with buffer layers like AlN (001). Layer transfer approach has been proposed for integration of such epitaxial Ru [1]. PVD epi-Ru can be suitable for interconnect metal lines through patterning and direct metal etch. However, it may not be ideal for via, even though some integration approaches explore to use it. CVD via filling remains an attractive integration approach for via metal [2]. Here we demonstrate epitaxial CVD Ru for selective via filling (Fig 1).

In this study, we used epitaxial PVD Ru (6 and 8 nm)/AlN (001)/Si(111) as substrates for CVD Ru experiments conducted in a CVD reactor. A series of preclean steps was applied to eliminate surface oxides and refresh the surface before CVD Ru growth under different deposition conditions. Powder XRD patterns (2θ-ω scans) show only Ru (*00l*) peaks, indicating CVD Ru film growth along *c*-axis. Representative CVD Ru film growth is shown in Fig 2. Laue oscillations at the bottom of Ru (002) peak are signature of epitaxial film growth. The Ru (101) Φ-scans collected at c=61.3^{o} show six-fold symmetry (Fig 3), like the underlying PVD epi-Ru, further confirming epitaxial CVD Ru film growth [1]. This paper will summarize systematic studies of CVD Ru film growth on PVD epi-Ru and characterizations including microstructure and electrical properties.

References:

1. C. Adelmann et.al, Epitaxial Ruthenium for Advanced Interconnects, IITC (2025) P32.
2. M. H. van der Veen, et. al, Selective Deposition and Ruthenium Superfill Exploration Beyond A10 Node Interconnects, VLSI Symposium (2025), T18-3.

Keywords: Interconnects, Ruthenium, Epitaxy, CVD

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