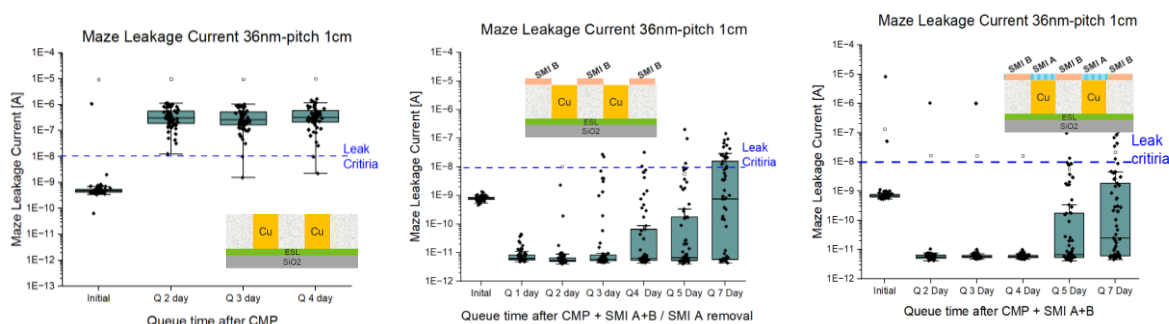


# Area Selective Ruthenium Deposition with Dual Inhibitors

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Area-selective deposition (ASD) has been pursued for decades in semiconductor manufacturing to cut reliance on costly masks and mitigate misalignment from wafer distortion [1]. Self-aligned and self-limited ASD schemes are integrated to protect electrical performance and preserve yield under aggressive scaling. In back-end-of-line (BEOL) processes, Cu interconnect scaling is becoming increasingly constrained at advanced nodes. Combining ASD techniques helps maintain Cu performance and reliability; selective barriers lower via resistance, and selective metal caps extend electromigration (EM) lifetime [2].

Building on the dual-inhibitor method reported at ASD 2024 [3], we apply sequential surface treatments that widen the window for selective Ru deposition on Cu while suppressing nucleation on interlayer dielectrics (ILD). The approach employs two small-molecule inhibitors (SMIs) to passivate both Cu and low-k surfaces after chemical mechanical planarization (CMP). Under Ru deposition conditions, the passivation is lifted on Cu but retained on the ILD, enabling selectivity without additional masking. Inline tests (ILT) show reduced leakage current and an enhanced ability to extend queue times without degradation [4-5]. This addresses queue-time control at fine pitches where the Cu/low-k spacing approaches critical dimensions. Plot 1-3 illustrate delayed leakage degradation with SMIs, and Fig. 1 confirms Ru selectivity on Cu with negligible ILD nucleation, indicating a path toward Cu interconnects with Ru wrap-around caps and improved electrical yield.



Plot 1(left): Maze leakage current degraded quickly from 100% to 0% after 48 hours queue time.  
 Plot 2 and 3 (Middle and right): Maze leakage current with SMIs treatments demonstrates no degradation after 96 hours and it remains 90% yield after 1 week queue.

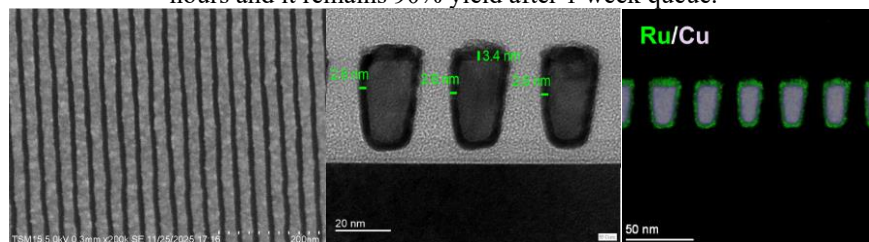


Fig 1-1 (left): Top-down SEM of Post Selective Ru cap on 32nm-pitch Cu line.

Fig 1-2 (middle) and Fig 1-3 (right): X-TEM and EDX mapping of Ru wrap-around Cu line 32nm-pitch.

## Reference

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