DPA26TZ06-DV004
Scalable Hard-mask materials with Improved Etch resistance and Low Degradation for Extreme-aspect-Ratio fabrication (SHIELDER)
Frequently Asked Questions (FAQs)

1. **Is this D2P2 something that will consider prior works sponsored by previous SBIR/STTR programs? What about ongoing funded SBIR/STTR activities?**

   From SBPO: they can submit feasibility from SBIR/STTR efforts because that work could be adopted as a follow-on to the initial SBIR/STTR effort (adoption).

2. **There may be tradeoffs when simultaneously reaching 150:1 selectivity, 100:1 aspect ratio, and sub-2 nm sidewall roughness—is it enough to demonstrate these one at a time (separately), or must they coexist in the final demonstration?**

   The final Phase II deliverable is structured as an integrated demonstration of all three performance objectives: etch selectivity >150:1, aspect ratio >100:1 on primary semiconductor substrates, and line-edge roughness of 2 nm or less. Achieving any single metric in isolation is often trivial (e.g., obtaining low roughness in a shallow etch); therefore, all proposals should show a clear path to demonstrating them together in a coherent final process flow.

   a) **For D2P2 eligibility, should the etching recipe produce >50:1 selectivity, >25:1 aspect ratio, and sidewall roughness <5 nm be from the same material/hard mask system, or can it be taken from multiple types of materials/hierarchies?**

      Proposals must show compelling prior-work evidence that the proposed novel hard-mask material(s) have achieved the stated feasibility metrics: >50:1 selectivity, >25:1 aspect-ratio pattern transfer, and <5 nm RMS sidewall roughness. Because DP2 proposals must establish feasibility of the proposed technology, a strong submission would show these metrics in the same candidate material system or in a clearly unified platform, rather than relying on unrelated demonstrations.

3. **What is the most favorable minimum resolvable feature size/critical dimension?**

   The most favorable minimum resolvable feature size/critical dimension largely depends on the proposal's target application but as stated in the solicitation, a

patterning resolution with features sizes of 100 nm or less must be demonstrated to showcase the revolutionary capabilities of the proposed technology.

4. **What is the metrology of choice for defining sidewall roughness? (combination of AFM, SEM)**

   Scanning electron microscopy (SEM), transmission electron microscopy (TEM), or Atomic Force Microscopy (AFM) are all acceptable metrology methods, as long as the feature sizes and sidewall roughness can be clearly identified and quantified.

5. **What wafer size is most favorable to demonstrate these etching results on?**

   There is no single preferred wafer size, as the format is often application-specific. However, the proposed deposition, patterning, and etching processes must be performed with standard cleanroom toolsets capable of handling standard-size wafers to ensure the technology can be scaled to production. Demonstrations on small coupons/wafers are acceptable for early-phase testing, provided there is a clear, documented pathway to transition the process to these standard wafer formats.

6. **What quantitative limits define acceptable contamination, CMOS compatibility, and thermal budget?**

   These limits are application- and/or facility-specific. However, as a general guideline, all proposals should ensure compatibility with standard commercial cleanroom environments, and provide details on the thermal budget for the target application.

7. **What is a sufficient baseline comparison? What is the minimum number of samples demonstrated to have the desired etching result?**

   Baseline comparison: The proposed hard mask must be compared with a standard baseline material, such as silicon dioxide, silicon nitride, or a sputtered metal such as TiN or Cr. The comparison should demonstrate that the novel mask retains structural integrity, critical-dimension fidelity, and low sidewall roughness under aggressive etch conditions in which the baseline mask erodes or facets. The solicitation specifically requires a statistically significant reduction in defect propagation and edge roughness relative to the baseline.

   Minimum samples: The solicitation does not require a minimum number of wafers or samples to be delivered. However, proposals should define a statistically

defensible sampling and replication plan sufficient to support the required comparative claim.

8. **What is the most favored application?**

   Any of the Department of War (DoW) relevant applications listed in the solicitation is acceptable: 3D integrated circuits, high-density memory arrays, MEMS inertial sensors and RF filters, integrated photonic devices, multiferroic memory and logic components. Proposers should select an application that provides a credible technical demonstration and a clear DoW or dual-use transition pathway.

9. **This hard mask should cover all etching processes (a "wonder material") or be specially designed for our etch of interest?**
   The solicitation does not require one hard-mask material to cover every etch process. It allows for a broad range of substrate and material platforms and anticipates application-specific demonstrations. Accordingly, a mask tailored to a defined substrate, plasma chemistry, and application is within scope, provided it meets the topic's performance, patternability, scalability, and compatibility expectations. However, the proposed mask must also demonstrate versatility. As specified in the Month 18 milestone, the mask must be validated on alternative, non-standard semiconductor or dielectric substrates and demonstrate a more relaxed selectivity of 50:1 on no fewer than two alternative materials, while scaling the coating process to larger wafer sizes.

10. **What is the quantitative metric from line-edge roughness? The solicitation uses the wording "ultra-low"**
    As specified in the solicitation, the Month 9 milestone calls for line-edge roughness of 5 nm or less; the final Month 24 demonstration calls for line-edge roughness of 2 nm or less.

11. **Is novel film processing considered a method to make novel hard mask materials/microstructures?**
    Yes. Novel film processing techniques (including, but not limited to, advanced chemical or physical vapor deposition, atomic layer deposition, spin-on precursor formulation, and post-deposition treatments) are considered valid methods to synthesize, modify, or deposit novel hard mask materials and microstructures, provided they meet the core etch selectivity, aspect ratio, and roughness metrics of the solicitation.