Development of Ancillary Photochemical Bulk Filters to Improve Particle Removal and Start-Up Time in Automated Delivery Systems

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INTRODUCTION

A semiconductor facility system is a highly complex and integrated environment designed to support the manufacturing of semiconductor devices. Central to the module tool is the Central Delivery System (CDS), which is crucial for supplying high-purity chemicals used in the manufacturing process. The CDS ensures that these materials are delivered consistently and safely to various points within the facility.

Filters play a vital role in the CDS by maintaining the purity and integrity of the chemicals. They are essential for removing microscopic particles before these materials reach the manufacturing equipment. This is critical because even tiny particles can cause defects in semiconductor devices. By ensuring that the materials remain free from contaminants, filters are important for achieving high yields and reliable performance, since the purity of chemicals prevents impurities that can affect the etching, deposition, and wafer cleaning processes.

Entegris developed next-generation photolithography filters for ancillary chemical applications including PGME/PGMEA(7:3), TMAH(aq), and nBA. In this study, we demonstrate the significant role that filters play in reducing process downtime by achieving faster filter priming speeds and minimizing excursions under normal process conditions. Our findings highlight the importance of selecting appropriate filters for ancillary, automated chemical delivery systems. These recommended filters not only enhance particle retention in chemicals but also reduce the metal content of the chemicals, ensuring high purity throughout the process. Additionally, the study shows that these filters can significantly shorten filter startup times, contributing to overall process efficiency and reliability.

EXPERIMENT

Filter Cleanliness Determinizing by Static Soaking in PGME/PGMEA(7:3), 2.38% TMAH(aq), and nBA

The determination of metal extractables of filters is evaluated by soaking 10-inch filter cartridges in 2.38% TMAH(aq) and nBA solvent respectively. The cartridge was placed into a 2-liter jar and soaked in 2.38% TMAH(aq) and nBA at room temperature. After 24 hours, the extraction solution was collected and analyzed by Inductively Coupled Plasma equipped with a Mass Spectrometry (ICP-MS) and Gas Chromatography Flame Ionization Detector (GC-FID) to qualify and quantify metal and organic extractables.

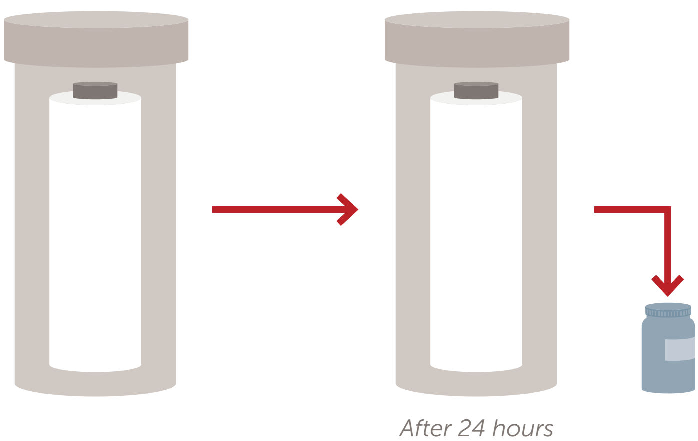

Figure 1. New 10-inch filter cartridges soaked in PGME/PGMEA(7:3), 2.38% TMAH(aq), and nBA for 24 hours.

RESULTS

Filter Cleanliness by Static Soaking in PGME/PGMEA(7:3)

Entegris has developed advanced cartridge filters, Microgard™ Nylon N01 and Microgard™ UPE D01, specifically for the CDS used in advanced semiconductor nodes. The key improvements in Nylon N01 and UPE D01 over existing filters like POR UPE and POR Nylon are their significantly tighter pore sizes and enhanced cleanliness levels.

The static soak test results reveal that both UPE D01 and Nylon N01 exhibit superior performance. They effectively reduce the presence of both metal and organic contaminants, which is crucial for maintaining the integrity and efficiency of semiconductor manufacturing processes. The advancements in pore size and cleanliness mean that these new filters can better protect sensitive equipment and ensure higher yield and quality in production.

PGME/PGMEA(7:3) Static Soaking in RT 24 Hours
Total Metals

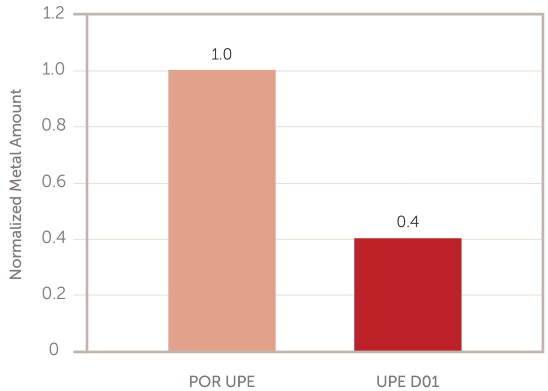

Figure 2. UPE D01 shows lower metal than POR UPE.

PGME/PGMEA(7:3) Static Soaking in RT 24 Hours
Total Organic Carbon (TOC)

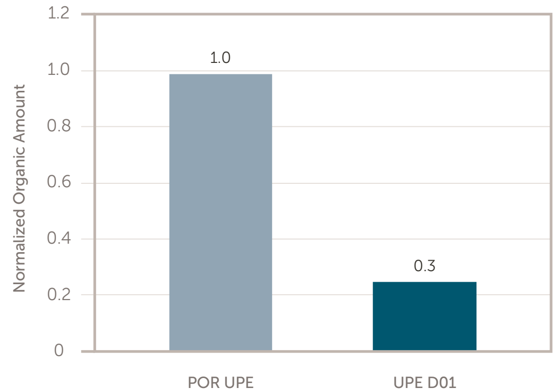

Figure 3. UPE D01 shows lower organic level than POR UPE.

PGME/PGMEA(7:3) Static Soaking in RT 24 Hours
Total Metals

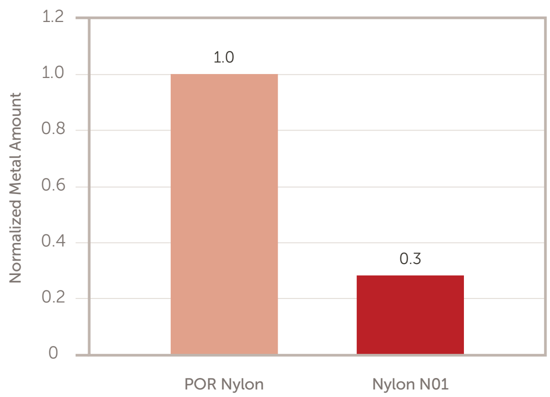

Figure 4. Nylon N01 shows lower metal level than POR Nylon.

PGME/PGMEA(7:3) Static Soaking in RT 24 Hours
Total Organic Carbon (TOC)

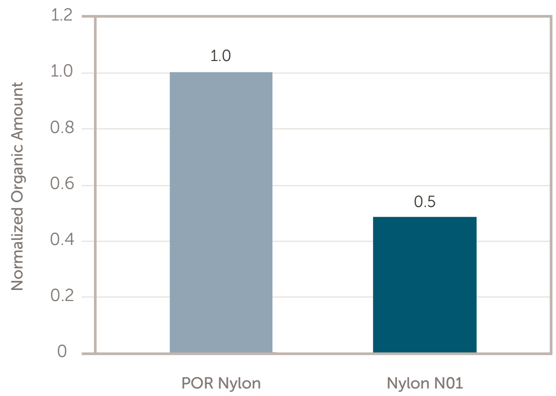

Figure 5. Nylon N01 shows lower organic level than POR Nylon.

Cleanliness by Extractables of Static Soaking Test – nBA

In the negative tone development systems using an nBA solution, Entegris has introduced the Microgard™ AT 2 nm dry version for advanced node CDS. The Microgard AT 2 nm dry version features a tighter pore size and enhanced cleanliness compared to the existing POR PTFE A. Static soaking test data indicates that the Microgard AT 2 nm dry version achieves a 50% reduction in metal contamination levels and 40% improvement in organic contamination levels compared to POR PTFE A.

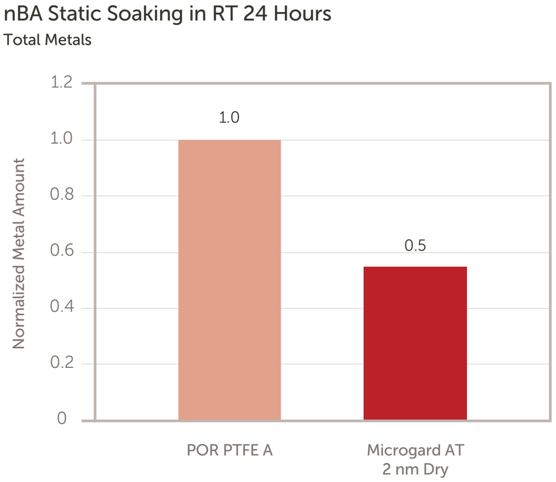

Figure 6. Microgard AT 2 nm dry version shows 50% improvement in metal contamination compared to POR PTFE A.

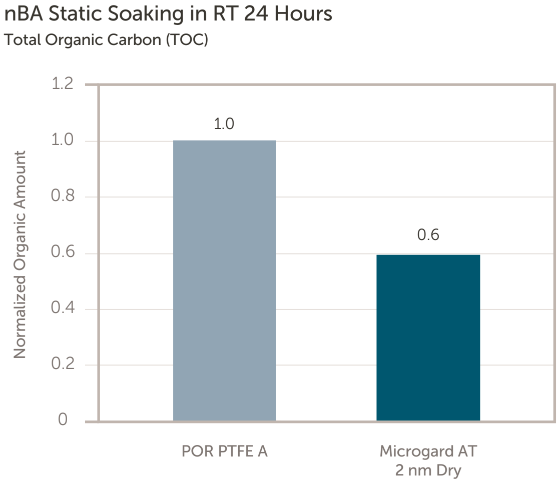

Figure 7. Microgard AT 2 nm dry version shows 40% improvement in organic contamination compared to POR PTFE A.

Cleanliness by Extractables of Static Soaking Test – 2.38% TMAH(aq)

For applications involving a 2.38% TMAH(aq) solution in positive tone development systems, Entegris has developed Microgard AT 2 nm prewet for use in advanced node CDS. Microgard AT 2 nm boasts a tighter pore size and superior cleanliness compared to the existing POR PTFE B. According to static soaking test data, Microgard AT 2 nm shows 90% improvement in metal contamination levels compared to POR PTFE B.

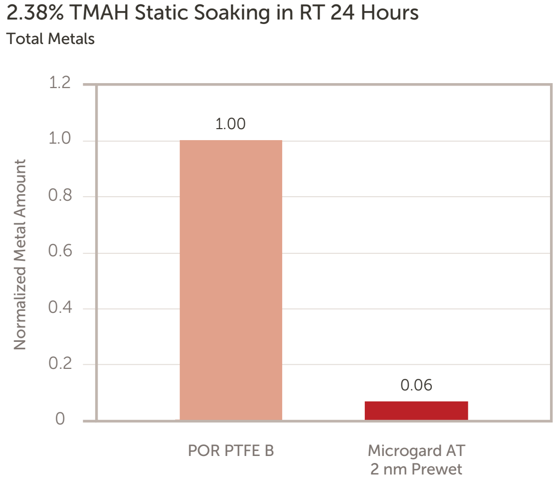

Figure 8. Microgard AT 2 nm shows 90% improvement in metal contamination levels compared to POR PTFE B.

CONCLUSION

Entegris' innovative filters—Microgard Nylon N01, UPE D01, Microgard AT 2 nm prewet, and Microgard AT 2 nm dry version—are set to bring substantial benefits to the semiconductor industry. As node sizes shrink, the demand for precision and purity in manufacturing increases.

Nylon N01 and UPE D01, developed for advanced node CDS, offer tighter pore sizes and better cleanliness compared to POR UPE and POR Nylon. Static soak tests show they effectively reduce both metal and organic contaminants.

The Microgard AT 2 nm dry version, designed for negative tone development systems using an nBA solution, shows a 50% reduction in metal contamination level compared to POR PTFE A. For 2.38% TMAH(aq) applications, Microgard AT 2 nm offers a 90% improvement in metal contamination level over POR PTFE B, thanks to its tighter pore size and superior cleanliness.

Overall, Entegris next-generation CDS filters promise enhanced performance and reliability in semiconductor manufacturing environments.

ACKNOWLEDGEMENTS

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