An Exploration of the Use of Fluoropolymers in Photofiltration

Aiwen Wu, Annie Xia – Entegris, Inc.

KEY TAKEAWAYS

- Polytetrafluoroethylene (PTFE) membranes have unique membrane structure and better flow performance compared to traditional UPE and nylon membranes
- Deliberately designed PTFE membranes with surface modification demonstrate high metal removal capability, particle retention, and good filter flush-up performance

ABSTRACT

Filtration technology has relied upon a subset of carefully matched materials to filter lithographic materials. The introduction of new materials for emerging lithography techniques creates the opportunity to seek alternatives to ultra-high molecular weight polyethylene (UPE), nylon, and polypropylene. Fluoropolymers such as PTFE and PFA have been used widely in the fab to filter chemistries that require instant surface wettability and high flow rates. These requirements now align more closely with today's leading-edge lithography materials. This paper will identify the critical material attributes, specific design considerations, and the importance of membrane surface technologies.

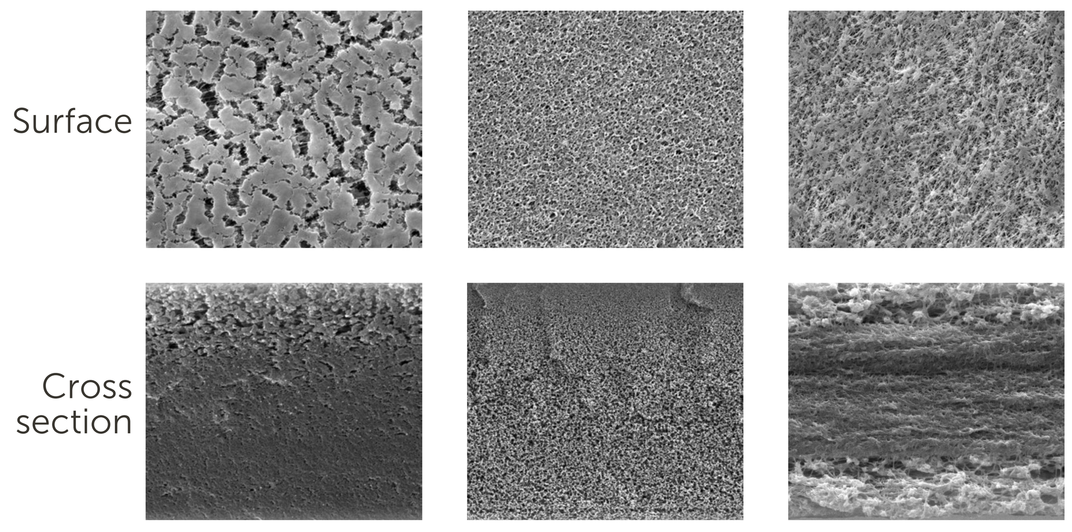
INTRODUCTION

Filters constructed with PTFE materials exhibit high flow rates, low levels of organic and ionic extractables, and excellent chemical compatibility. New photohemistries are now more closely aligned with the requirements of the wet etch and cleans chemistries to address photolithography requirements.

Performance factor	Aggressive solvents	Photochemicals
Flow	✓	✓
Removal efficiency	✓	✓
Cleanliness	✓	✓
Compatibility	✓ (with fluorinated polymer housings)	✓

New chemistries, including n-butyl acetate (nBA) and methyl isobutyl carbinol (MIBC), have been introduced into the track to extend the viability of 193 nm immersion lithography processes as negative tone developers (NTD). PTFE filters were introduced into the track to filter these materials.

There is an increasing interest in using PTFE filters for other materials. PTFE has a very different membrane morphology than other photochemical filters. The different morphology changes the way contaminants flow through and are captured within the membrane.



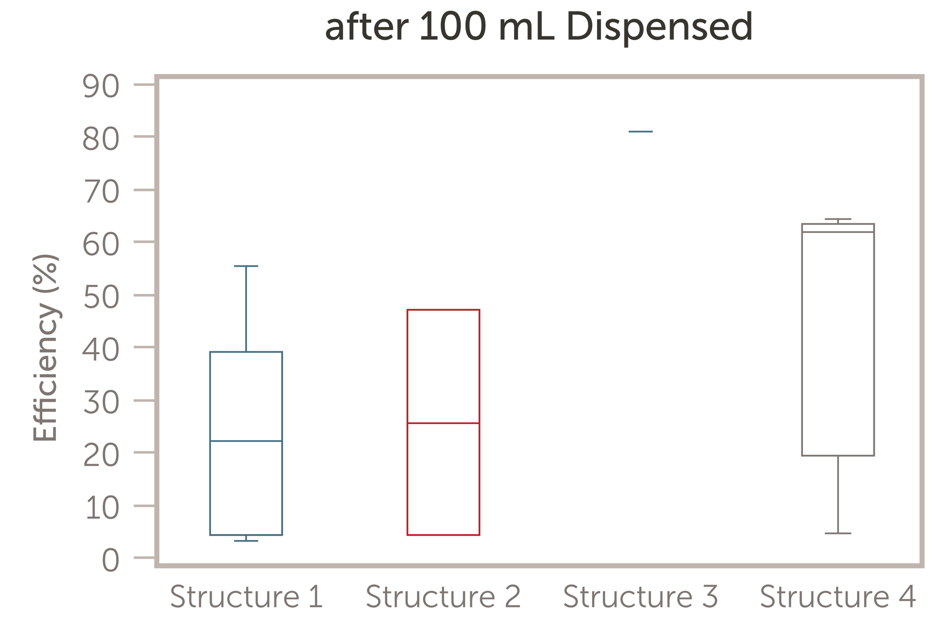
EXPERIMENT AND RESULTS

- Flow performance
- Metal removal efficiency
- Retention studies
- On-wafer defectivity studies

	PTFE membrane	UPE membrane
10" cartridge flow in DIW (RT) @ 20 kPa	17 L/min	8 L/min
Organics performance limit (mg/device)	<3.5	≤30
Metals extractables limit (µg/device)	<4; Fe and Ca <0.5; Na <1.5; all other individual metals <0.3	<30
Particles in DIW (≥50 nm/10 mL)	<25	<50

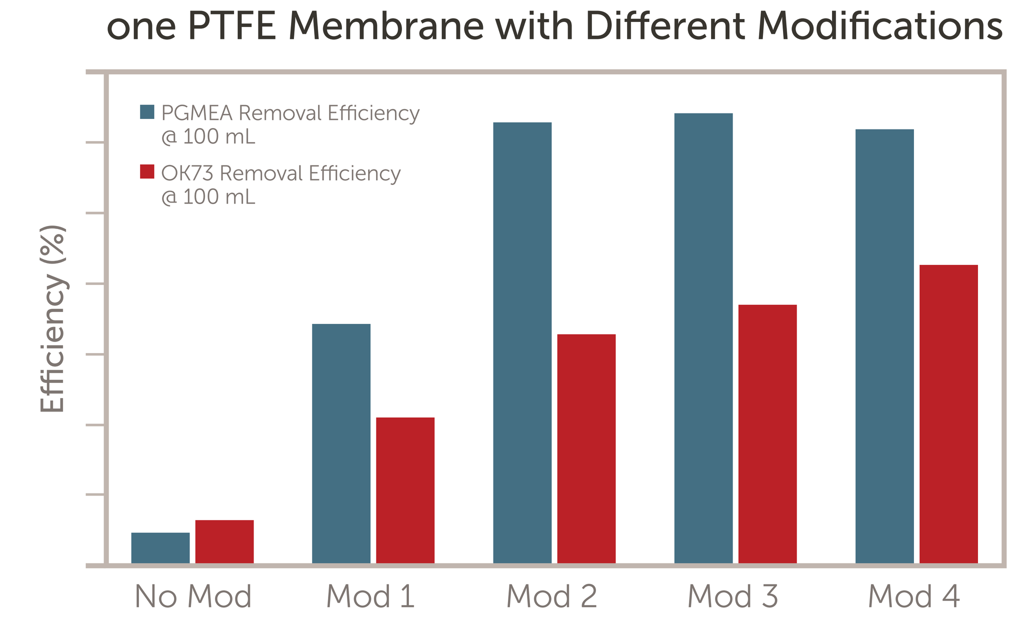
PTFE membranes of a similar nominal pore rating show a better flow performance. This is a particularly attractive feature for developer and solvent dispense where the rate and volume is much higher than that of resist dispense. PTFE membranes generally have better cleanliness than UPE membranes.

Metals Removal Efficiency in PGMEA after 100 mL Dispensed



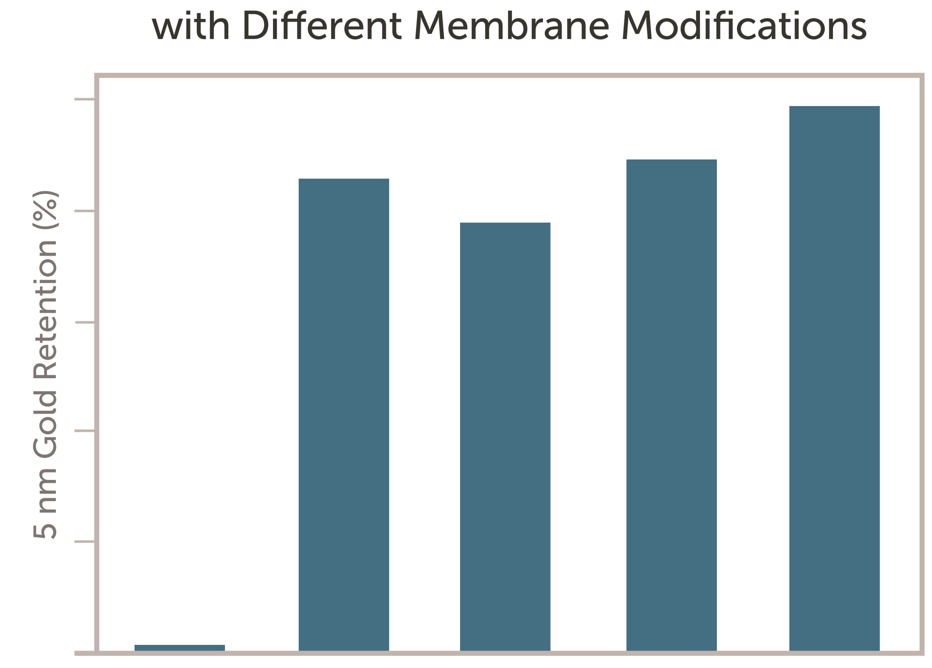
All PTFE membranes tested showed some ability to remove metallic contaminants from solvent.

Metals Removal Efficiency in PGMEA and OK73 of one PTFE Membrane with Different Modifications



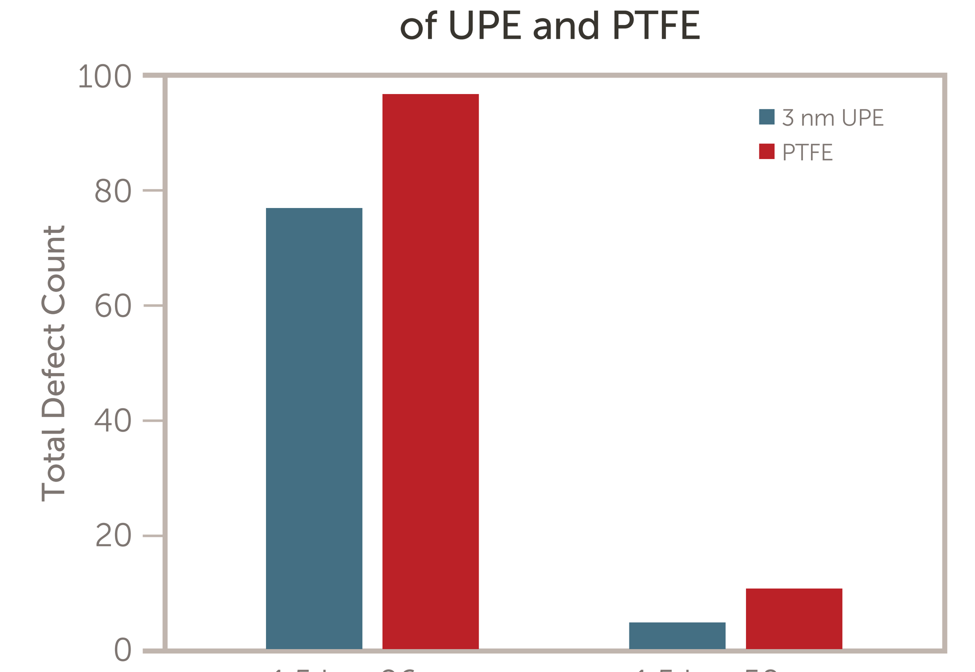
Membranes based on Structure 1 were modified for metal removal tests in PGMEA and OK73. Modifications 2 through 4 show the best performance in both PGMEA and OK73.

5 nm Gold Retention on One PTFE Membrane with Different Membrane Modifications



The same membranes showed a similar trend to the metals removal efficiency results in 5 nm gold particle retention studies, however Modification 1 also shows a strong ability to retain the 5 nm gold particles.

Filter Flushing Comparison of UPE and PTFE



A filter flush-up test was performed on a TEL LITHIUS Pro™ Zi system using OK73 with a KLA-Tencor Surfscan® SP3. Results show comparable performance at both 26 nm and 50 nm detection sizes for PTFE and UPE membranes.

CONCLUSIONS

- PTFE filters have been introduced to filter NTD developer and rinse materials in advanced lithography processes; the interest in using PTFE filters for other materials is increasing
- PTFE membrane structure and surface modification need to be deliberately designed to address photolithography filtration requirements