SiMPore
Precision Membrane Technologies

Microplastic Filtration and Analysis

Impact of analytical filter surface on total analysis time: Bigger isn't always better!

Introduction

Analytical laboratories are constantly faced with balancing the costs and benefits of processing time, consumables cost, and the quality of collected data. When analyzing samples for microplastics, practitioners must consider laborious sample preparation, instrument data collection time, data analysis, and reporting time.

This study compares two membranes - a commonly used 20 µm gold-coated polycarbonate track etched (PCTE-Au) analytical filter, against a 20 µm gold-coated microporous silicon nitride (MPSN-Au) analytical filter made by SiMPore. Two concepts in specific are analyzed:

1 - Membrane "concentration factor", in which a smaller active area concentrates particle loads, and thereby decreases analysis time - total analysis time is measured at a baseline through automated microscopy image acquisition.

2 - Material convenience via comparing the total manual handling time and reported handling ease.

Filters were compared by recording the time it took to handle/manipulate into and out of a vacuum filtration apparatus, transferring to microscope, preparing an automated, coordinated-based microscopy process via µManager, and timing how long image acquisition takes. Additionally, triplicate experimental vacuum filtrations of 1L of clean water were conducted at -97.9 kPa for both filter types.

For each filter, a 25 mm clear-cast PDMS gasket with a 10 mm opening was utilized.

Results

MPSN1000-1Q30-20-Au Filter Disk
Gold-coated, 20 µm pore

A - Device image
B - 10x microscopy
C - SEM - 500x

PCTE-Au
Gold-coated, 20 µm pore

D - Device image
E - 10x microscopy
F - SEM - 500x

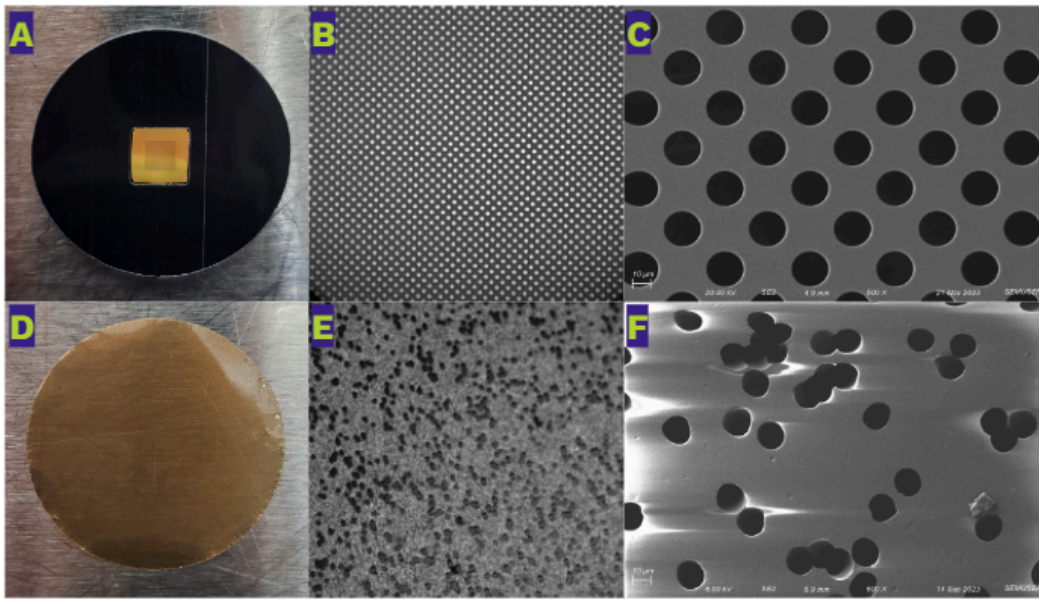

Figure 1: Macro-photography, 10x Microscopy, and 500x SEM images taken of MPSN-Au (A-C) and PCTE-Au (D-F)

MPSN-Au is a 310 µm thick Silicon Nitride chip, etched via photolithography with a 1000 nm thick, 9 mm^2 central membrane, and coated with 120 nm of gold. The MPSN-Au chip is then permanently bonded to a laser-cut black acetal housing to create the Filter Disk. PCTE-Au filters are a 3 µm thick track-etched sheet of polycarbonate that is coated with a layer of gold that varies between 20 - 40 nm on one or both sides, depending on the brand. Panels B and E depict both filters under 10x simultaneous transmission and reflectance microscopy. Panels C and F are 500x SEM micrographs of both filters, showcasing microstructures and pore morphologies. In Panel E, the right side of the PCTE image is out of focus - this is due to filter wrinkling after handling out of the box.

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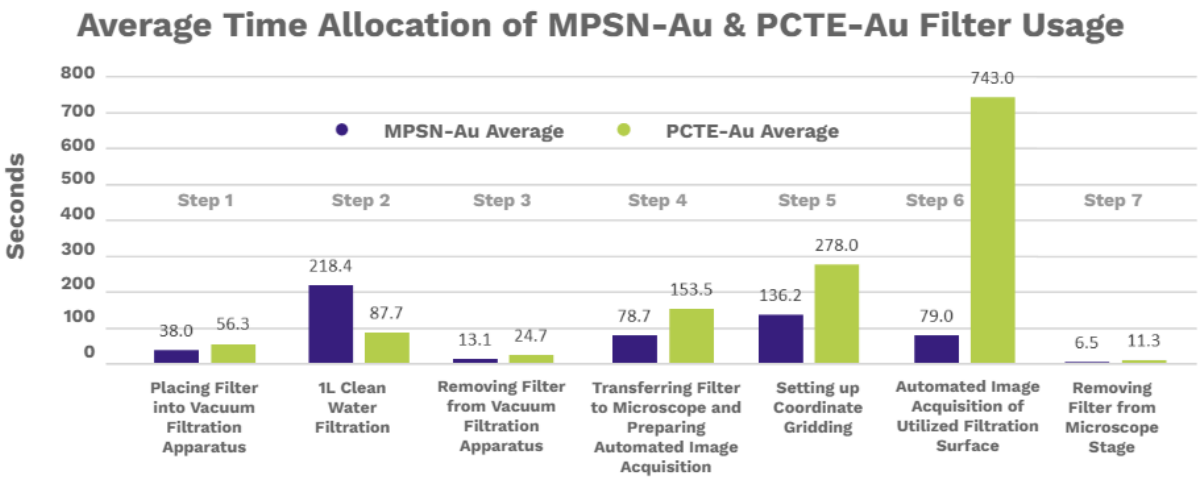

Figure 2: The process of manual manipulation, vacuum filtration, and microscopy image acquisition of each filter was broken into 7 steps and individually timed in triplicate for each membrane type, then averaged. Step 1 included removal from the manufacturer-supplied storage box. Steps 2 and 6 utilized 25 mm clear-cast PDMS gaskets with a 10 mm opening for all filtrations and imaging sessions.

- MPSN-Au active area - **9 mm²**
- PCTE-Au active area - **78.54 mm²**

Conclusions

- When including experimental filtration time, automated acquisition, and manipulation time, **MPSN-Au filters can be processed 85.13% faster than PCTE-Au filters**
- In an 8-hour workday, 66 MPSN-Au vs. 26 PCTE-Au total sample processing events can be collected, respectively.
- PCTE-Au filters tended to wrinkle and fold during manipulation, which increased manual handling and transfer time, as well as increased microscopy data acquisition time, as shown in Figure 2.
- The effectively higher concentration factor and lack of focal plane differences of MPSN-Au filters reduced manipulation and analysis time.
- Less time spent imaging, handling and looking for particles = lower total analysis time and overall higher lab throughput.

Methods

- All labware and gaskets rinsed in triplicate with MilliQ water prior to each filtration.
- The same exact pieces of labware, gaskets, and materials were utilized for each filter type.
  - Gaskets used for each filtration were 25 mm clear-cast PDMS with a 10 mm circular inlet.
- A researcher with significant experience with both filter types conducted the timed handling testing for all tests.
- Timed testing for handling time started as the researcher opened the box provided by the manufacturer to house both filter types.
- Microscopy images taken on an Olympus BX61 utilizing both reflectance and transmission modes
- Auriga field emission SEM (Carl Zeiss Vision) utilized for SEM micrographs.

Acknowledgements

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Reference - Carter, J. et al. Comparative Evaluation of Filtration and Imaging Properties of Analytical Filters for Microplastic Capture and Analysis .Chemosphere 2023, 332, 138811

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