Supplementary Information

Enhanced 3D Sponge with Asymmetric Wettability: An Efficient Solution for Ultra-Low Resistance Oil Aerosol Filtration Over Extended Durations

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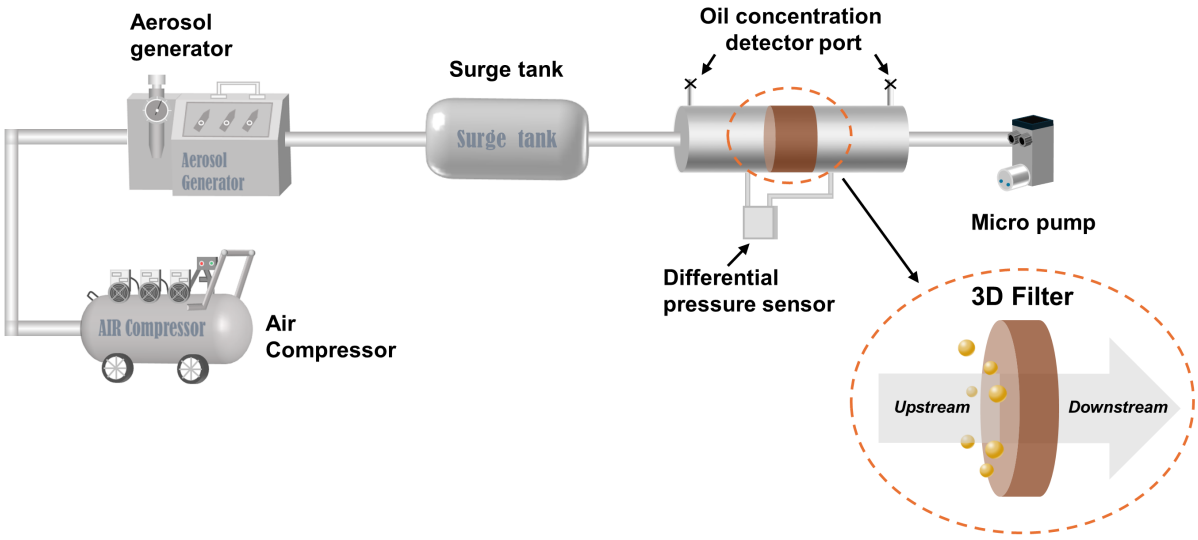

Fig. S1 A schematic diagram of oil aerosol filtration device.

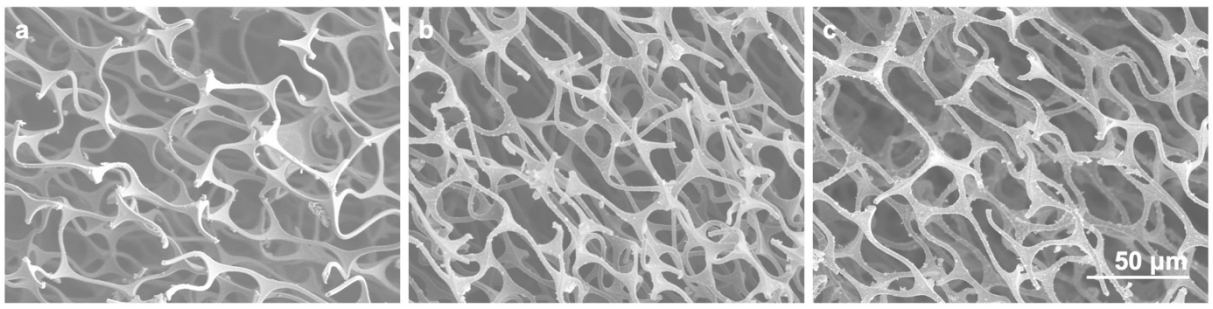

Fig. S2 Low magnification SEM image of a) the MF sponge substrate; b) SALS; c) SABS.

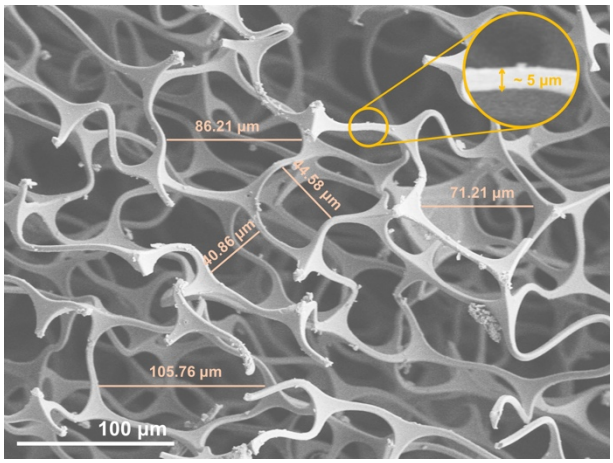

Fig. S3 The structural characteristics of the pristine MF sponge.

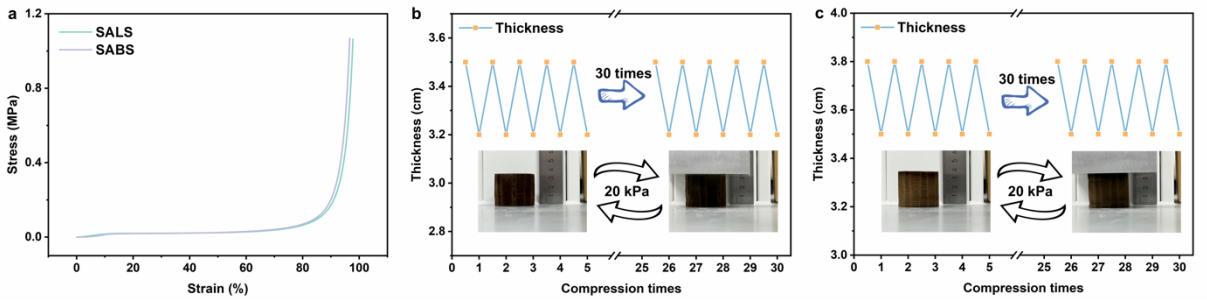

Fig. S4 The mechanical properties of SALS and SABS: a) The stress-strain curve during compression; b) Cyclic compression-recovery tests of SALS under a 30 kPa load for 30 cycles; c) Cyclic compression-recovery tests of SABS under a 30 kPa load for 30 cycles.

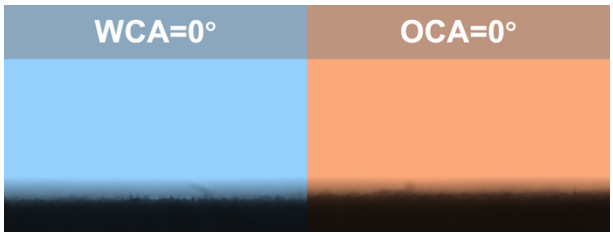

Fig. S5 Wettability characterization of SALS.

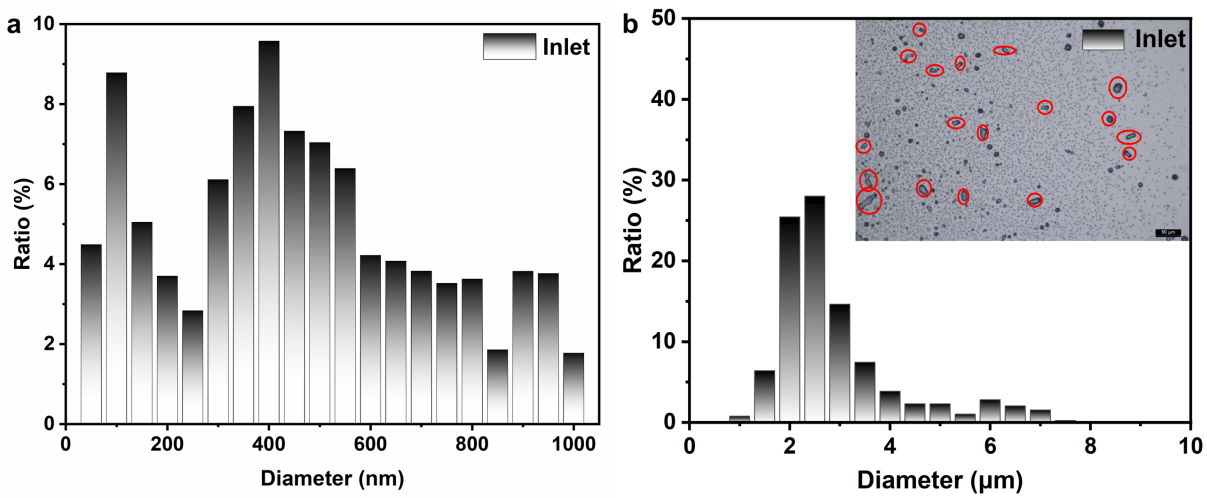

Fig. S6 The oil droplet size distribution in the oil aerosol: a) Small oil mists (<1 μm); b) Large oil mists (>1 μm).

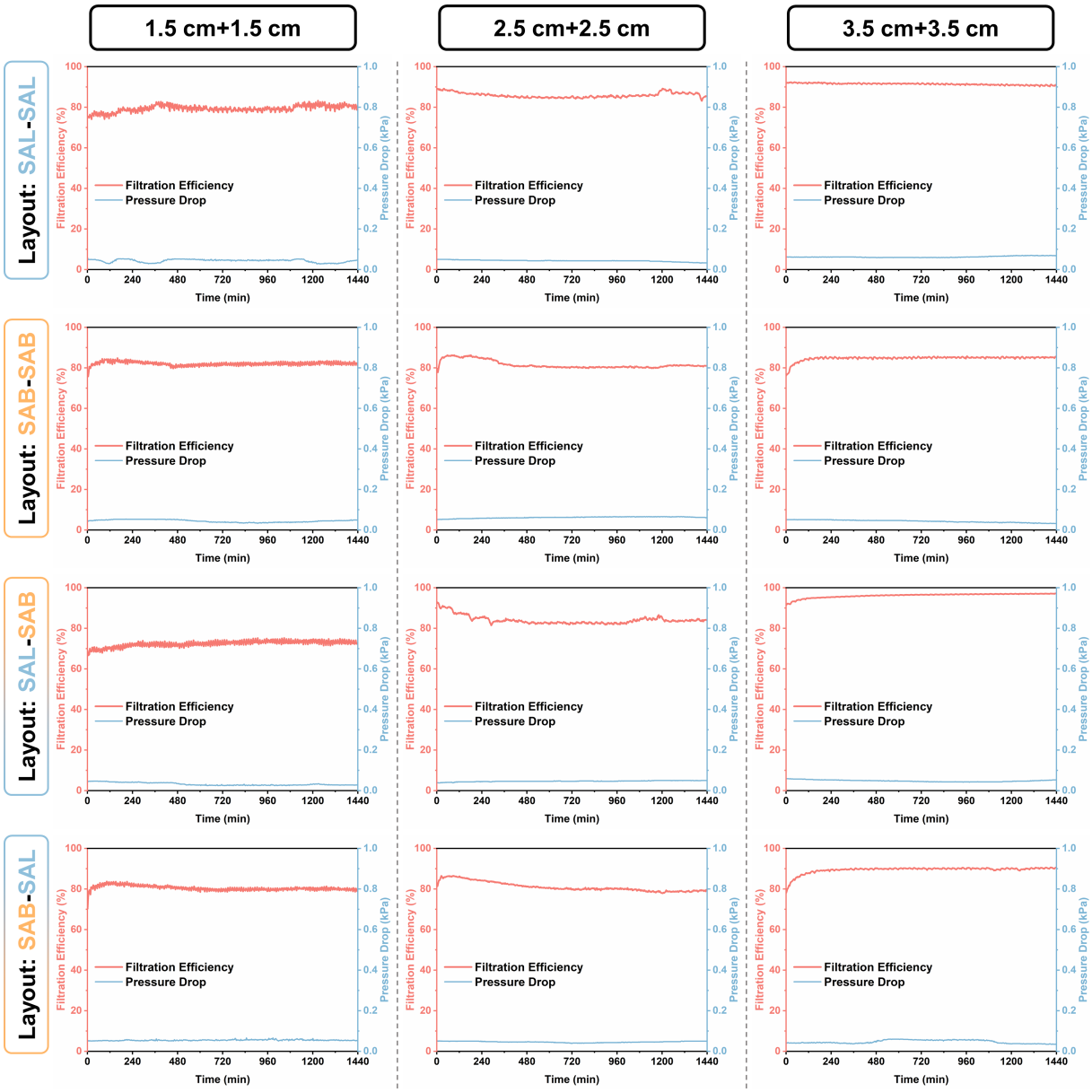

Fig. S7 The filtration efficiency and pressure drop curves of the 24-hour filtration process for the 12 layouts.

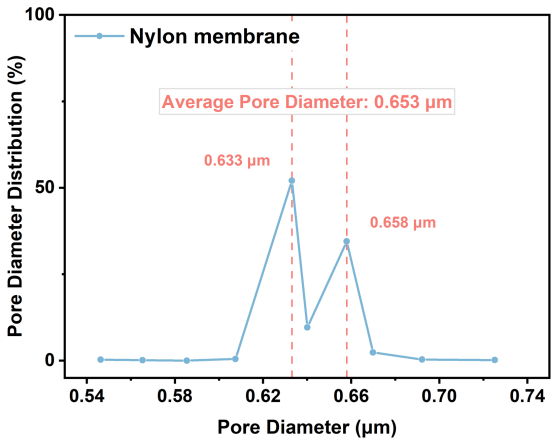

Fig. S8 The pore size distribution of the nylon membrane substrate.

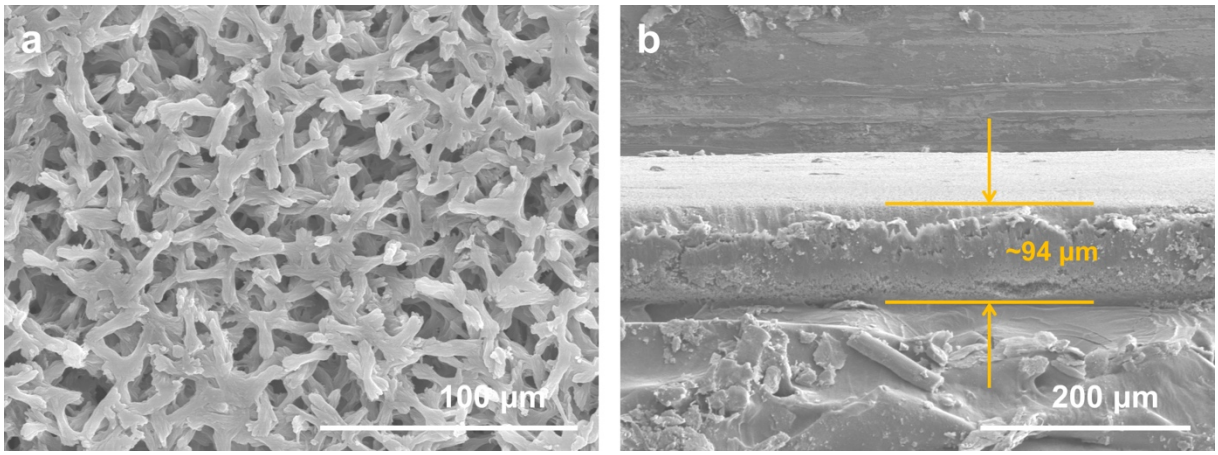

Fig. S9 The morphology and thickness characterization of the nylon membrane substrate.

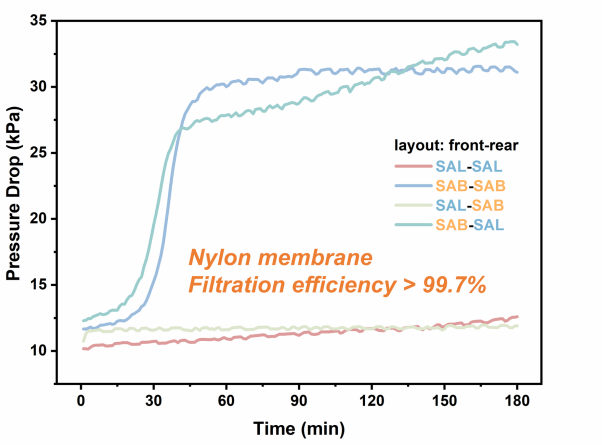

Fig. S10 The filtration pressure drop curves of the 3-hour filtration process for the 4 layouts for filter prepared by nylon membrane.

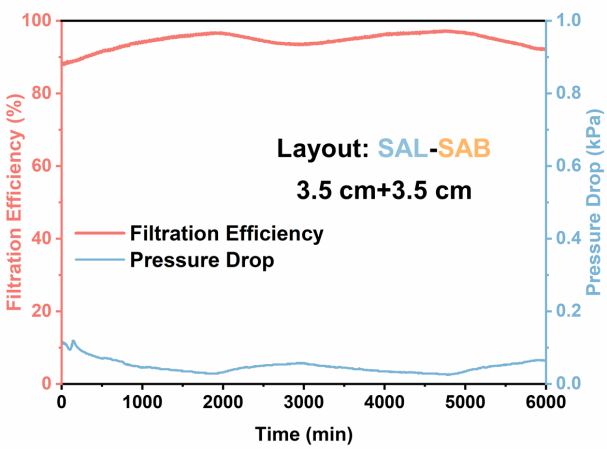

Fig. S11 The filtration efficiency and pressure drop curves of the 100-hour filtration process for the 3D filter under optimal condition.

Table S1 Gas permeance of different filter materials

No.	Material	Gas permeance (m^3 m^{-2} h^{-1} kPa^{-1})
1	MF sponge	3105.1 ± 98.6
2	SALS	3112.3 ± 71.1
3	SABS	3101.5 ± 106.3
4	Nylon membrane	19.1 ± 2.8

Table S2 Comparison of different materials for oil aerosol filtration.

No.	Year	Material	Material type (2D/3D)	Filtration duration (h)	Filtration efficiency (%)	Pressure drop (kPa)	Quality factor (kPa^{-1})	Ref.
1	2012	Filter media embedded with Teflon fiber	2D	3	99.75	3.53	1.70	[1]
2	2018	PFAP@GF	2D	-	99.4	8.33	0.61	[2]
3	2018	PFTMS@nano-SiO_2/ePTFE	2D	1	97.7	3.1	1.22	[3]
4	2018	Oleophobic coalescing filters	2D	-	99.8	3.8	1.64	[4]
5	2019	Superoleophobic coalescing filters	2D	20	99.9	3.5	1.97	[5]
6	2020	PFAP@GF with asymmetric wettability	2D	2.5	99.65	3.41	1.67	[6]
7	2020	PFTMS-SiO_2@PTFE	2D	1	99.25	2.4	2.03	[7]
8	2021	PFDTES-grafted SiO_2@GF	2D	1	99.37	8.56	0.59	[8]
9	2022	FOTS-grafted TiO_2@SiC	2D	12	98.24	11	0.37	[9]
10	2022	F-SiO_2@OTS-PTFE	2D	0.2	99.96	3	2.61	[10]
11	2023	FOTS-TiO_2@SiO_2 NFM	2D	5	99.87	7	0.95	[11]
12	2020	3D knitted spacer fabrics air filter	3D	0.5	90	0.06	38	[12]
13	2025	Thickness-Direction Asymmetric 3D Filter	3D	24	96.16	0.048	67.71	**This work**

Reference

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