

Appendix D2

ESEM and SEM/EDS Data for Test #2, Day-30 Fiberglass in High- and Low-Flow Zones

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The debris accumulated on fiberglass in the ICET tests is of great interest because it may contribute to additional head loss during recirculation of the coolant following a LOCA. To evaluate the potential for debris accumulation, fiberglass samples submerged in high- and low-flow zones in the tank were examined by ESEM and SEM/EDS.

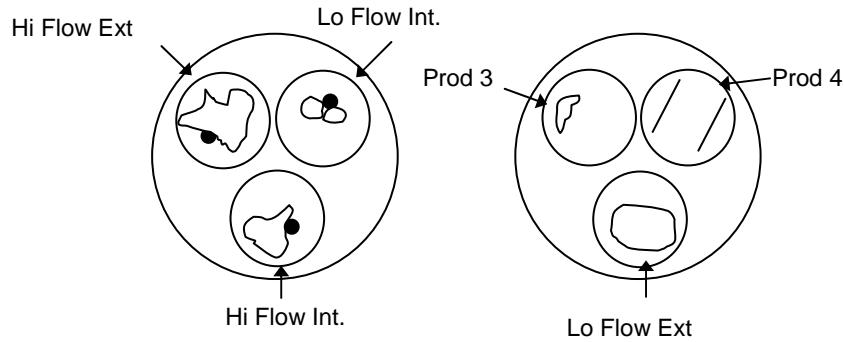
The fiberglass samples examined in this appendix were extracted on the date Test #2 was terminated (March 7, 2005). Both exterior and interior locations on the fiberglass samples were examined. Microprobe SEM was used to examine the fiberglass samples after they were air dried at room temperature and then coated with gold/palladium. In addition to microprobe SEM, ESEM was used to analyze the wet fiberglass samples without any coating. ESEM was performed under a low-vacuum condition (80 Pa) to minimize any modification of the fiberglass that could occur through the drying process. Microprobe SEM/EDS and ESEM results of Test #2, Day-30 high- and low-flow fiberglass samples were obtained on March 7 and March 9, 2005, respectively. Accompanying EDS results provide a semiquantitative elemental analysis of the debris deposited on the fiberglass.

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Transcribed Laboratory Log

Microprobe laboratory session from March 7, 2005

T2D30 Samples—NRC



Conditions: 15-kV, 1-nA beam current, Aperture = 2

Sample: Low-Flow Exterior

Image:	T2D30_LoFlo014	43 ×	Overview SE image	Figure D2-1
	T2D30_LoFlo015	500 ×	SE near center	Figure D2-2
	T2D30_LoFlo016	1500 ×	SE image on same area	Figure D2-3

Sample: High-Flow Exterior

Image:	T2D30_HiFlo017	40 ×	Overview SE image	Figure D2-4
	T2D30_HiFlo018	230 ×	Center of image 017	Figure D2-5
	T2D30_HiFlo019	1000 ×	Lower right of image 018	Figure D2-6
	T2D30_HiFlo020	700 ×	New area	Figure D2-7
EDS:	T2D30EDS13		Film on high-flow fiberglass	Figure D2-8

Sample: High-Flow Interior

Image:	T2D30_HiFlo021	40 ×	SE image overview	Figure D2-9
	T2D30_HiFlo022	180 ×	SE image near center of 021 image	Figure D2-10
	T2D30_HiFlo023	1000 ×	Same area	Figure D2-11

EDS:	T2D30EDS14		Film on fiberglass Hi Flow interior	Figure D2-12
Image:	T2D30_HiFlo024	500 ×	SE on different area of sample	Figure D2-13

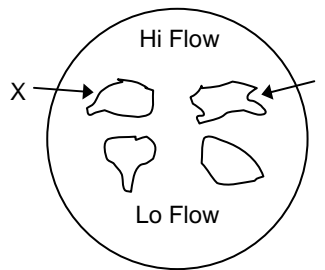
Sample: Low-Flow Interior

Image:	T2D30_LoFlo025	350 ×	On possible bacteria or Ca Phosphate	Figure D2-14
EDS:	T2D30EDS15		Globular cluster from image 025	Figure D2-15
Image:	T2D30_LoFlo026	800 ×	Different area	Figure D2-16

Transcribed Laboratory Log

ESEM Laboratory session from March 8, 2005

T2D30 Low-Vacuum SEM



Conditions: 20-kV, 12-mm Working Distance, 80 Pa pressure

Sample: High-Flow Interior

Image:	T2D30HI1	150 ×	Overview	Figure D2-17
	T2D30HI2	1000 ×		Figure D2-18

Sample: High-Flow Exterior

Image:	T2D30HX3	150 ×	Overview	Figure D2-19
	T2D30HX4	1000 ×		Figure D2-20

Sample: Low-Flow Exterior

Image:	T2D30LX5	150 ×		Figure D2-21
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T2D30LX6 1000 × On debris

Figure D2-22

Sample: Low-Flow Interior

Image: T2D30LI7 150 ×

Figure D2-23

T2D30LI8 1000 ×

Figure D2-24

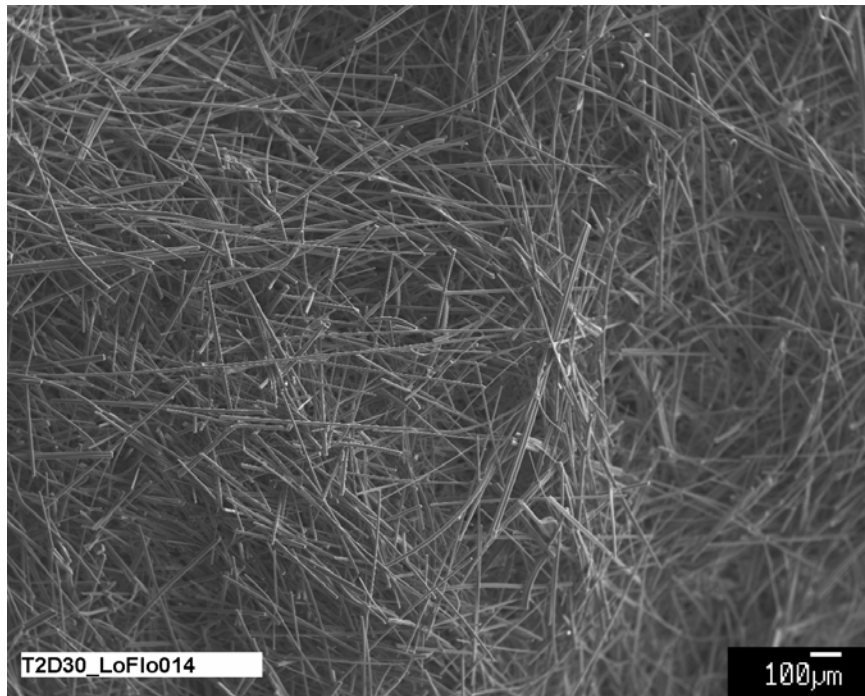


Figure D2-1. SEM image for a Test #2, Day-30 low-flow exterior fiberglass sample. (T2D30_LoFlo014)

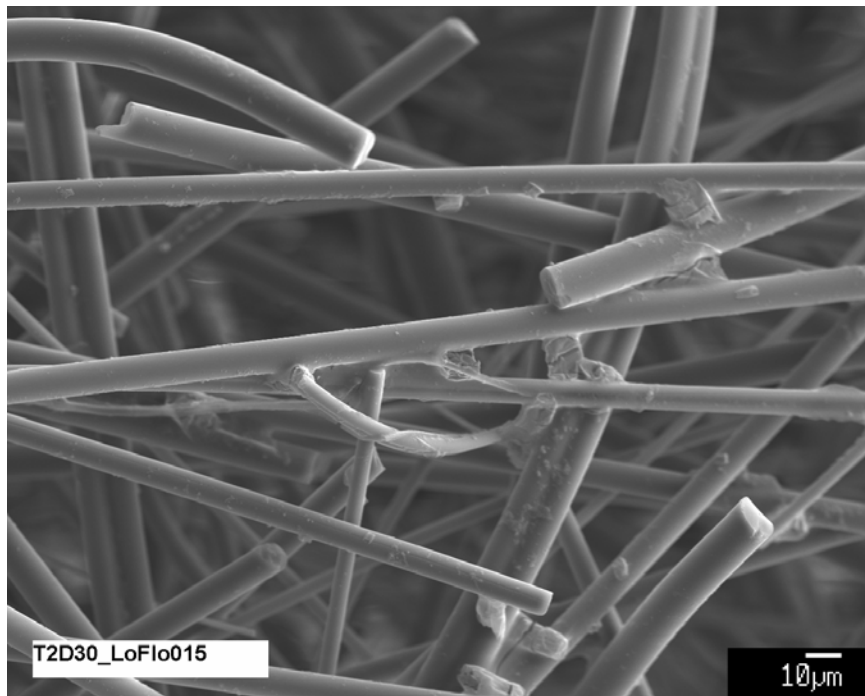


Figure D2-2. SEM image of a higher magnification for a Test #2, Day-30 low-flow exterior fiberglass sample. (T2D30_LoFlo015)

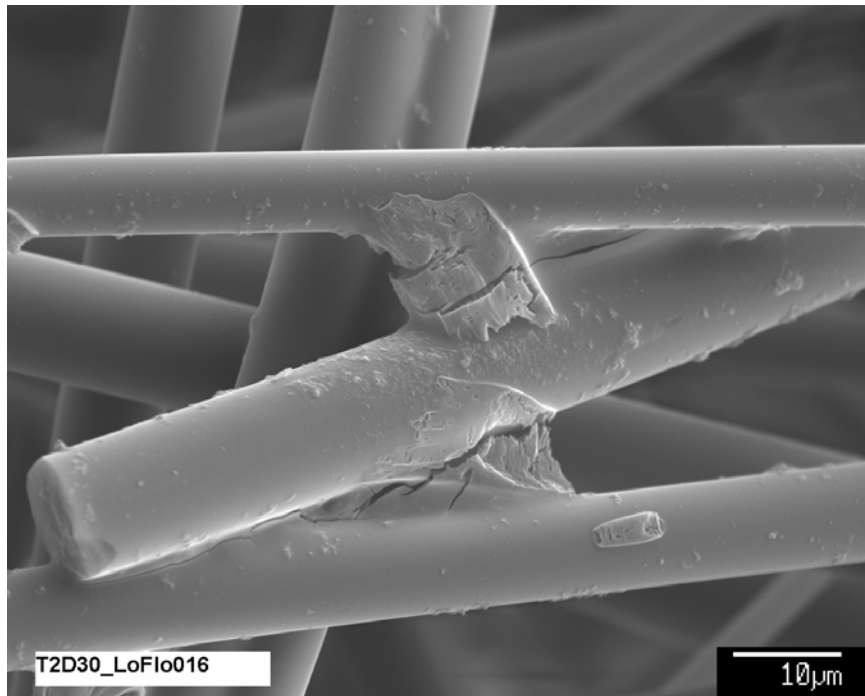


Figure D2-3. SEM image of a higher magnification for a Test #2, Day-30 low-flow exterior fiberglass sample. (T2D30_LoFlo016)

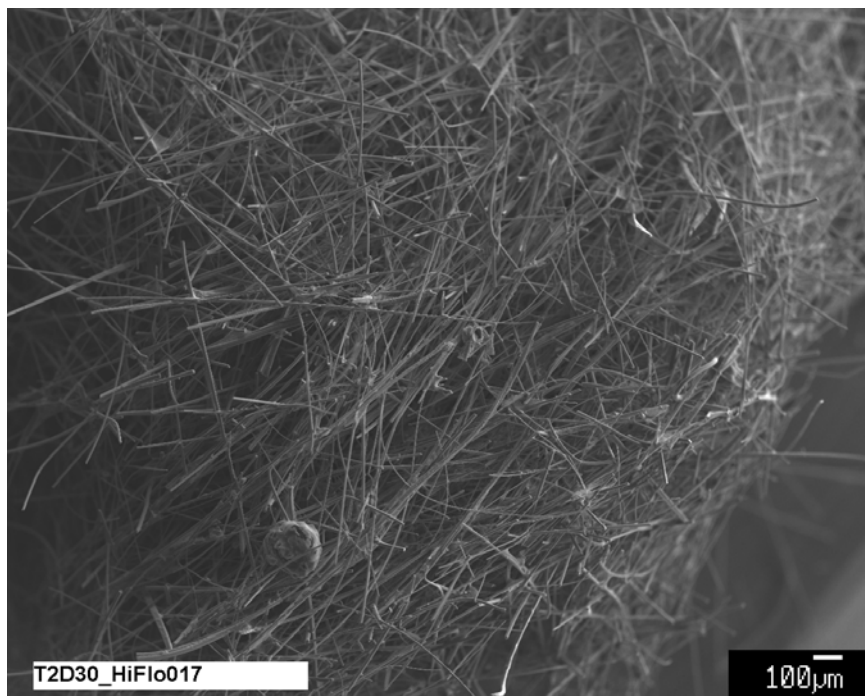


Figure D2-4. SEM image for a Test #2, Day-30 high-flow exterior fiberglass sample. (T2D30_HiFlo017)

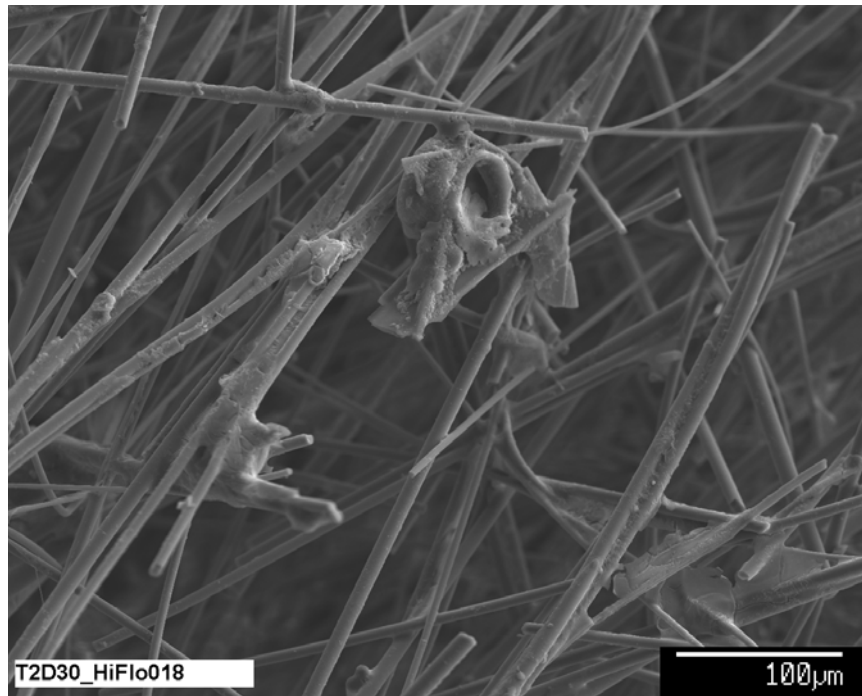


Figure D2-5. SEM image for a Test #2, Day-30 high-flow exterior fiberglass sample. (T2D30_HiFlo018)

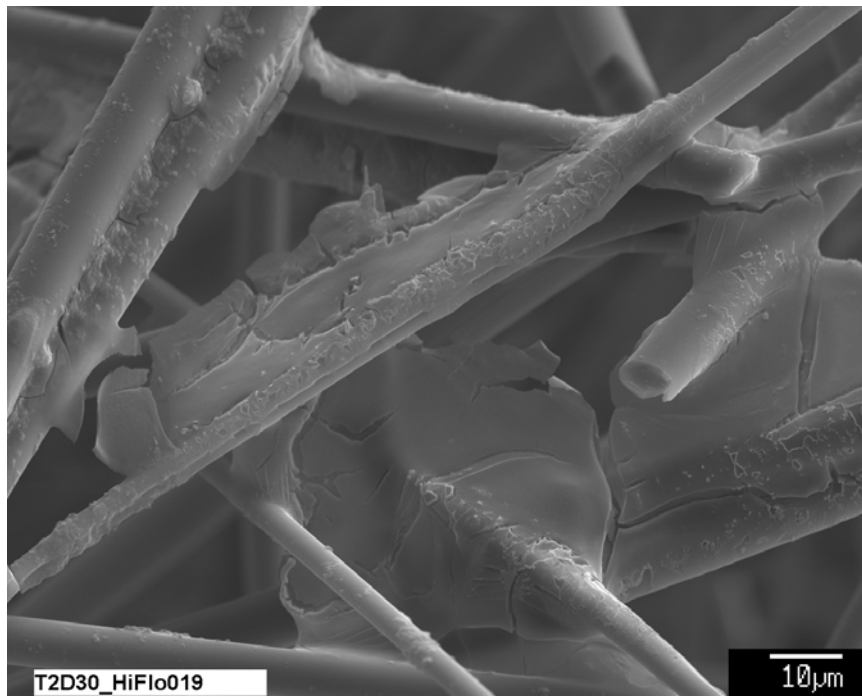


Figure D2-6. SEM image of a higher magnification for a Test #2, Day-30 high-flow exterior fiberglass sample. (T2D30_HiFlo019)

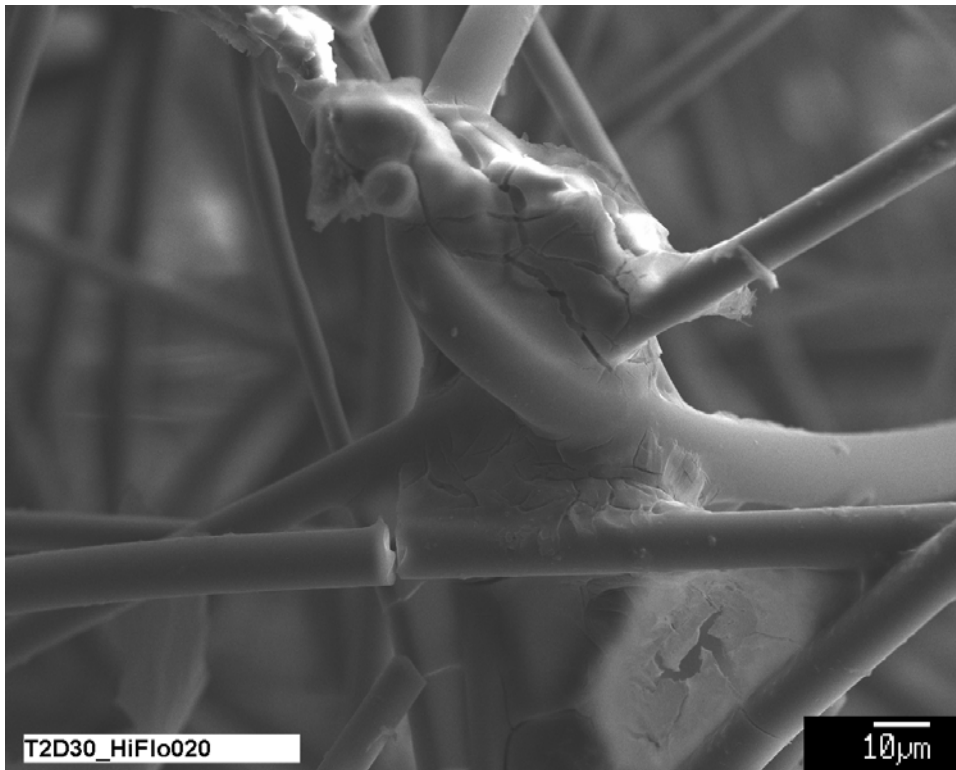


Figure D2-7. SEM image of a higher magnification for a Test #2, Day-30 high-flow exterior fiberglass sample. (T2D30_HiFlo020)

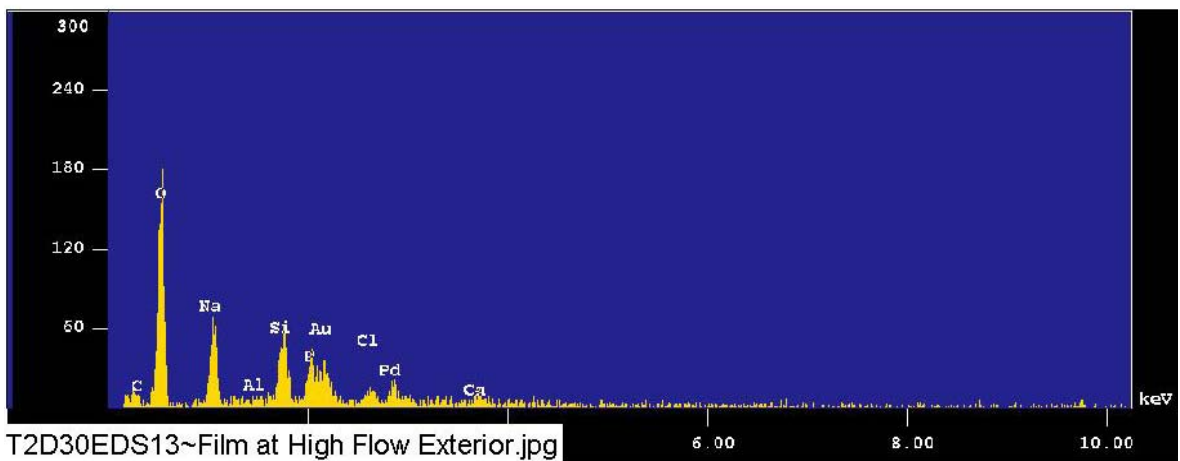


Figure D2-8. EDS counting spectrum for the film deposits or growth on fiberglass, as shown in Figure D2-7. (T2D30EDS13~Film at High Flow Exterior)

The results from the chemical composition analysis for T2D30EDS13 are given in Table D2-1.

Table D2-1. The Chemical Composition for T2D30EDS13 (Figure D2-8)

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```

Group       : NRC
Sample      : T2D30 ID# : 13
Comment     : film on HiFlow fiberglass
Condition   : Full Scale : 20KeV(10eV/ch,2Kch)
              Live Time  : 60.000 sec      Aperture #   : 1
              Acc. Volt  : 20.0 KV         Probe Current  : 3.247E-10 A
              Stage Point: X=48.137 Y=56.660 Z=10.558
              Acq. Date  : Mon Mar 7 17:20:30 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
C K	Normal	0.09- 0.46	0.0000	0.0000	0 /	15
O K	Normal	0.25- 0.77	22.7584	0.0029	1420 /	8
Na K	Normal	0.81- 1.27	2.3831	0.0008	576 /	4
Si K	Normal	1.50- 2.05	1.2480	0.0002	522 /	18
P K	Normal	1.75- 2.38	1.3516	0.0016	300 /	34
Cl K	Normal	2.34- 3.06	0.4706	0.0004	143 /	5
Ca K	Normal	3.39- 4.30	0.4212	0.0006	103 /	3

 Chi_square = 2.5421

Element	Mass%	Atomic%	ZAF	Z	A	F
C	0.000	0.0000	6.0057	1.0404	5.7730	0.9999
O	68.212	77.9670	0.7076	0.9928	0.7128	1.0000
Na	15.750	12.5283	1.5604	1.0448	1.4934	1.0001
Si	7.284	4.7427	1.3779	0.9953	1.3873	0.9980
P	4.750	2.8046	0.8298	1.1782	0.7048	0.9993
Cl	2.197	1.1335	1.1025	1.0478	1.0529	0.9993
Ca	1.806	0.8239	1.0120	1.0156	0.9965	1.0000

 Total 100.000 100.0000
 Normalization factor = 4.2357

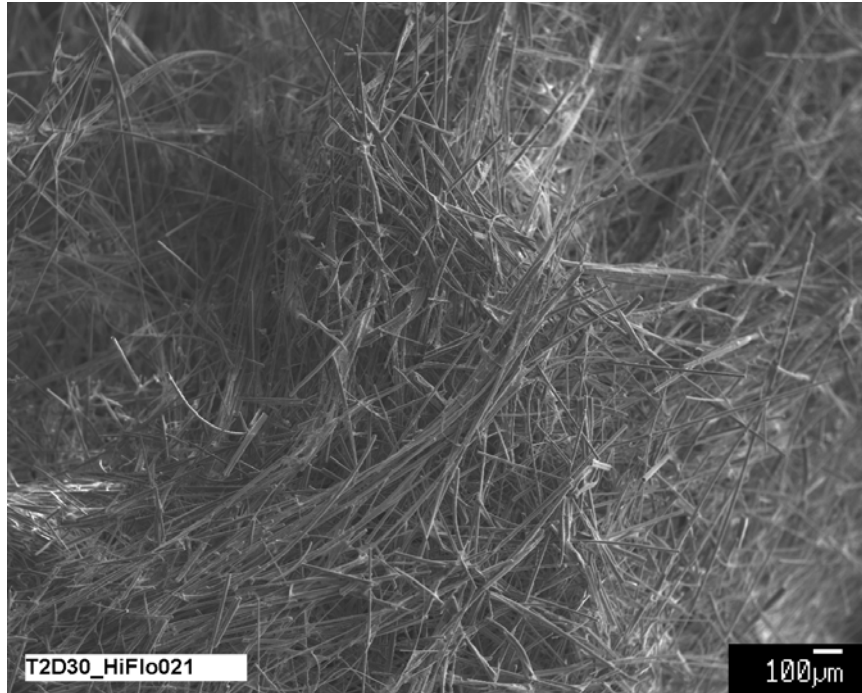


Figure D2-9. SEM image for a Test #2, Day-30 high-flow interior fiberglass sample. (T2D30_HiFlo021)

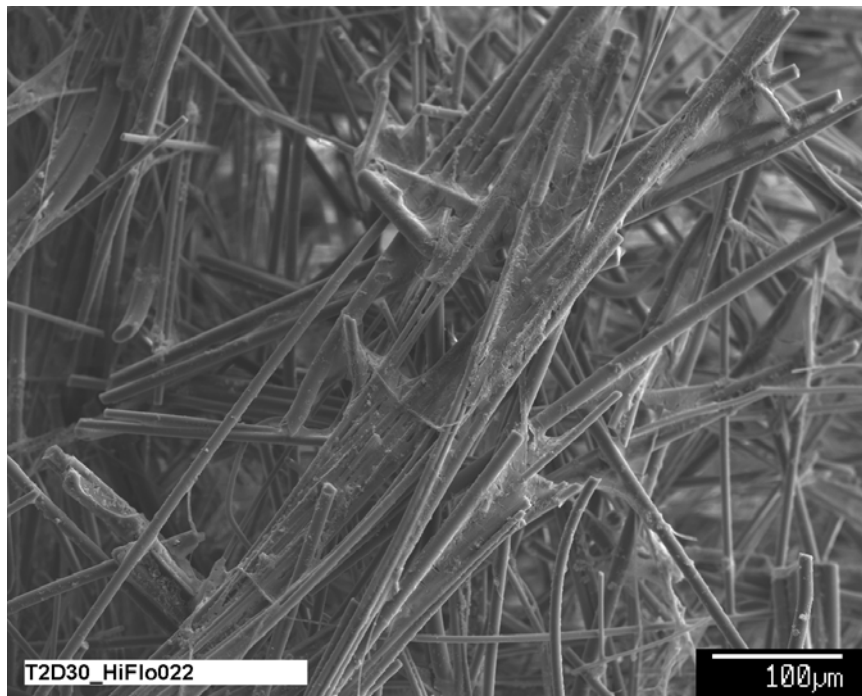


Figure D2-10. SEM image for a Test #2, Day-30 high-flow interior fiberglass sample. (T2D30_HiFlo022)

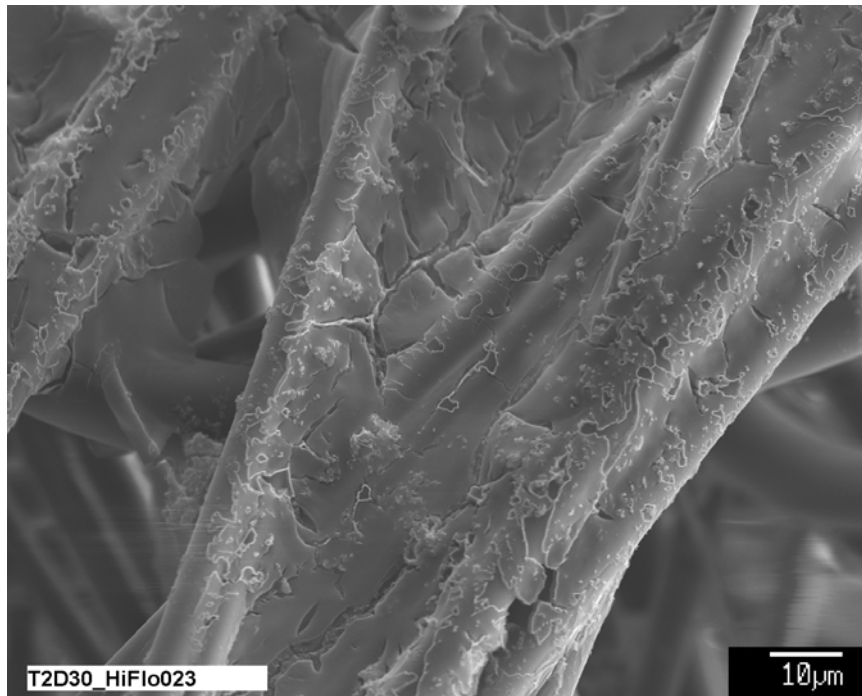


Figure D2-11. SEM image at 1000× magnification for a Test #2, Day-30 high-flow interior fiberglass sample. (T2D30_HiFlo023)

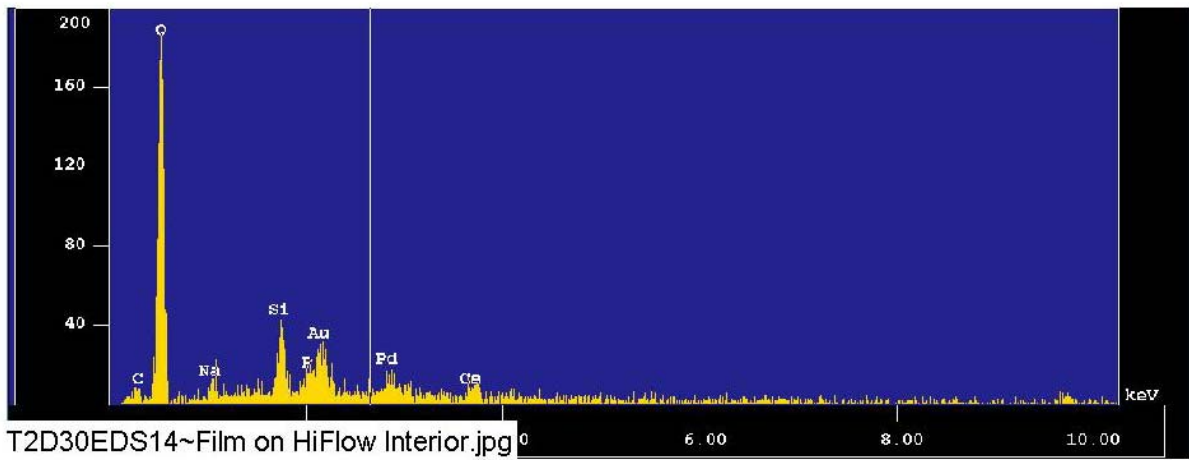


Figure D2-12. EDS counting spectrum for the film deposits or growth on fiberglass, as shown in Figure D2-11. (T2D30EDS14~Film on HiFlow Interior)

The results from the chemical composition analysis for T2D30EDS14 are given in Table D2-2.

Table D2-2. The Chemical Composition for T2D30EDS~14 (Figure D2-12)

Mar 7 17:37 2005 /tmp/eds_pout.log Page 1

```

Group      : NRC
Sample     : T2D30 ID# : 14
Comment    : film on hi flow fiberglass interior
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec   Aperture #   : 1
             Acc. Volt  : 20.0 KV      Probe Current : 3.155E-10 A
             Stage Point: X=43.227 Y=69.357 Z=10.558
             Acq. Date  : Mon Mar 7 17:34:53 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
C K	Normal	0.09- 0.46	0.0000	0.0000	0 /	18
O K	Normal	0.25- 0.77	23.9534	0.0029	1452 /	6
Na K	Normal	0.81- 1.27	0.4162	0.0004	98 /	4
Si K	Normal	1.50- 2.05	0.7810	0.0002	317 /	14
P K	Normal	1.75- 2.38	0.2529	0.0013	55 /	26
Ca K	Normal	3.39- 4.30	0.4296	0.0005	102 /	5

 Chi_square = 3.6593

Element	Mass%	Atomic%	ZAF	Z	A	F
C	0.000	0.0000	3.8510	1.0451	3.6851	0.9999
O	85.150	90.8939	0.5770	0.9974	0.5785	1.0000
Na	4.620	3.4320	1.8017	1.0498	1.7160	1.0002
Si	6.368	3.8722	1.3235	1.0003	1.3239	0.9994
P	1.246	0.6870	0.7999	1.1842	0.6756	0.9999
Ca	2.616	1.1148	0.9886	1.0213	0.9680	1.0000

 Total 100.000 100.0000
 Normalization factor = 6.1604

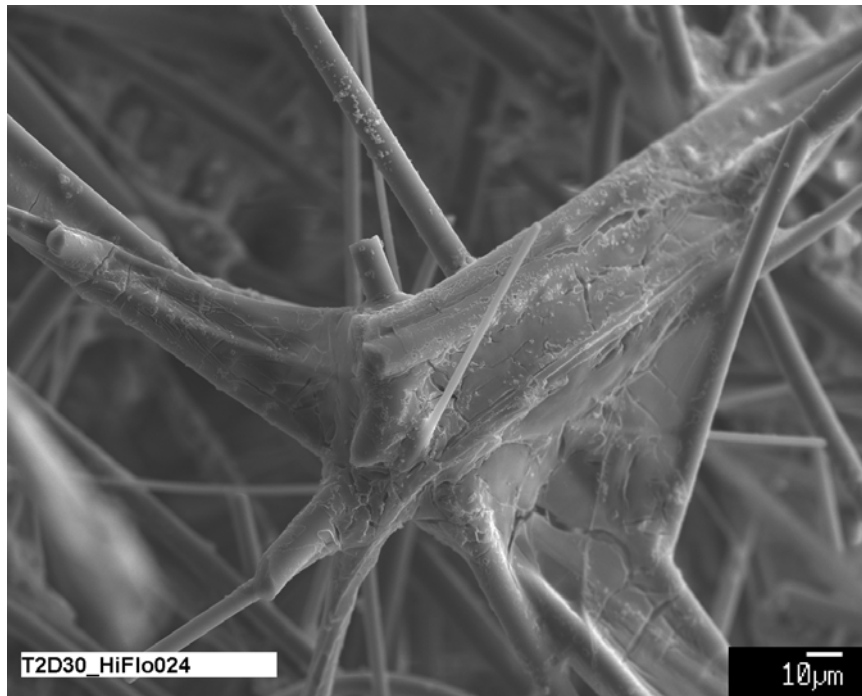


Figure D2-13. SEM image of a higher magnification for a Test #2, Day-30 high-flow interior fiberglass sample. (T2D30_HiFlo024)

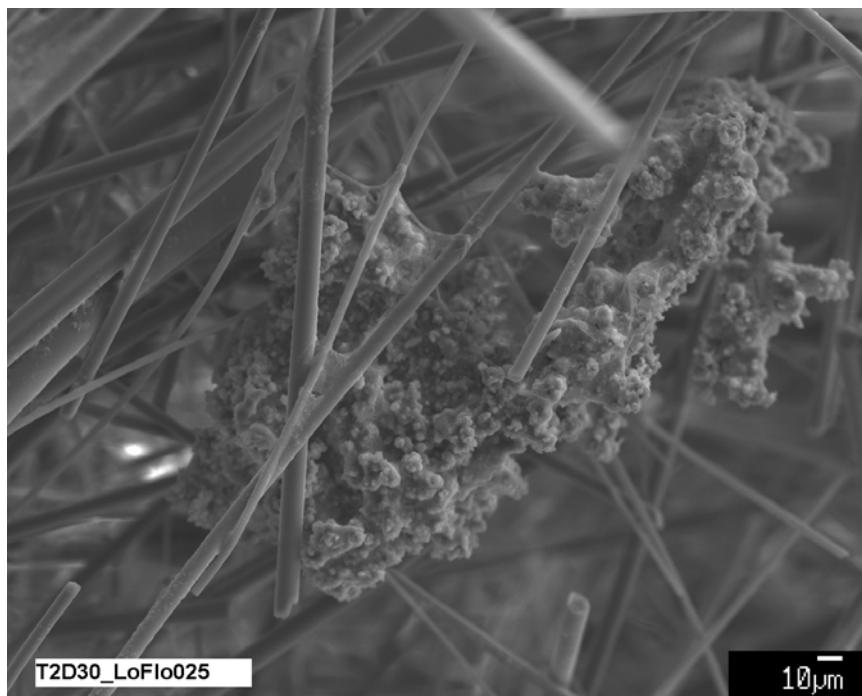


Figure D2-14. SEM image for a Test #2, Day-30 low-flow interior fiberglass sample. (T2D30_LoFlo025)

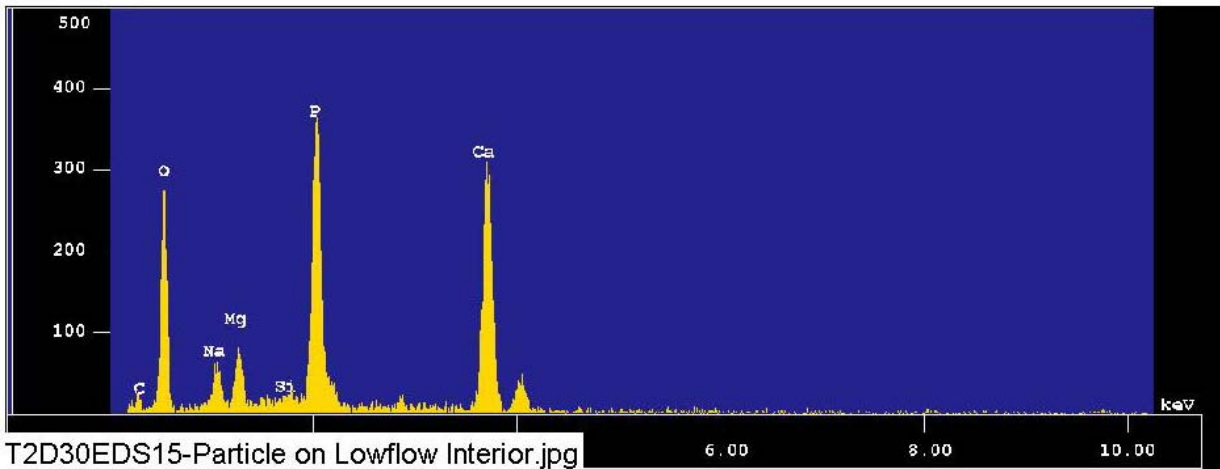


Figure D2-15. EDS counting spectrum for the particulate deposits or growth on fiberglass, as shown in Figure D2-14. (T2D30EDS15-Particle on Lowflow Interior)

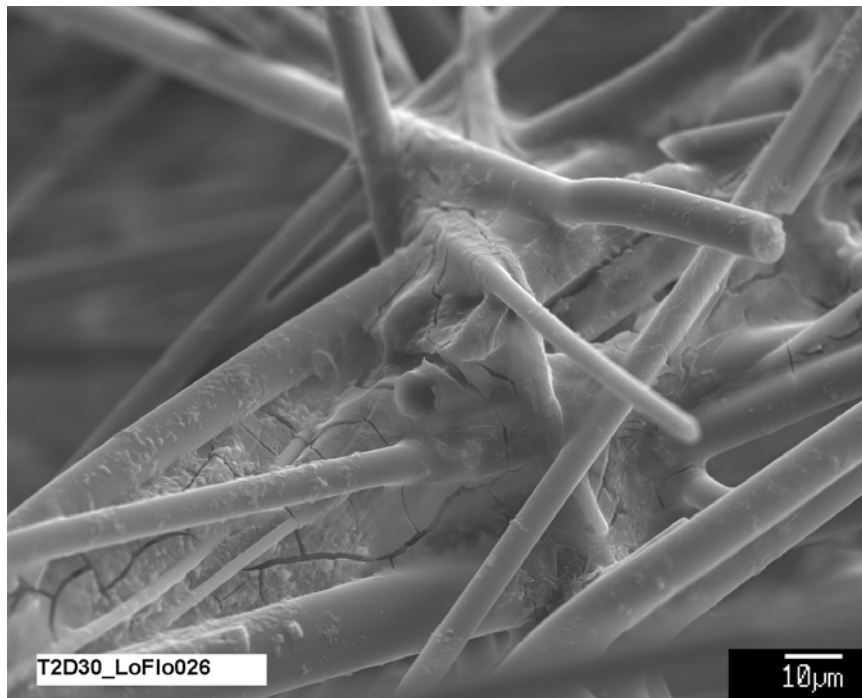


Figure D2-16. SEM image of a higher magnification for a Test #2, Day-30 low-flow interior fiberglass sample. (T2D30_LoFlo026)

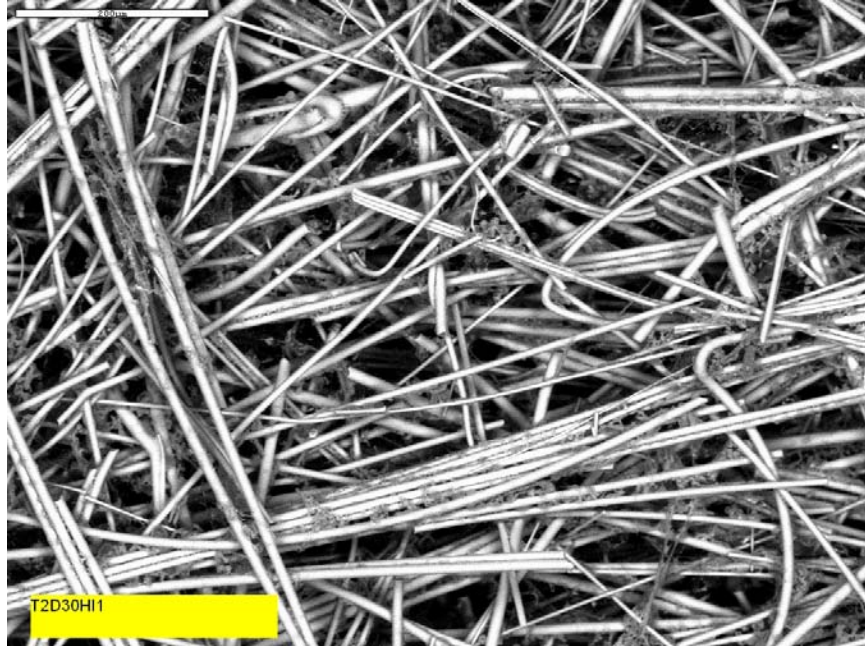


Figure D2-17. ESEM image for a Test #2, Day-30 high-flow interior fiberglass sample. It seems the interior fiberglass is cleaner than exterior fiberglass. (T2D30HI1)

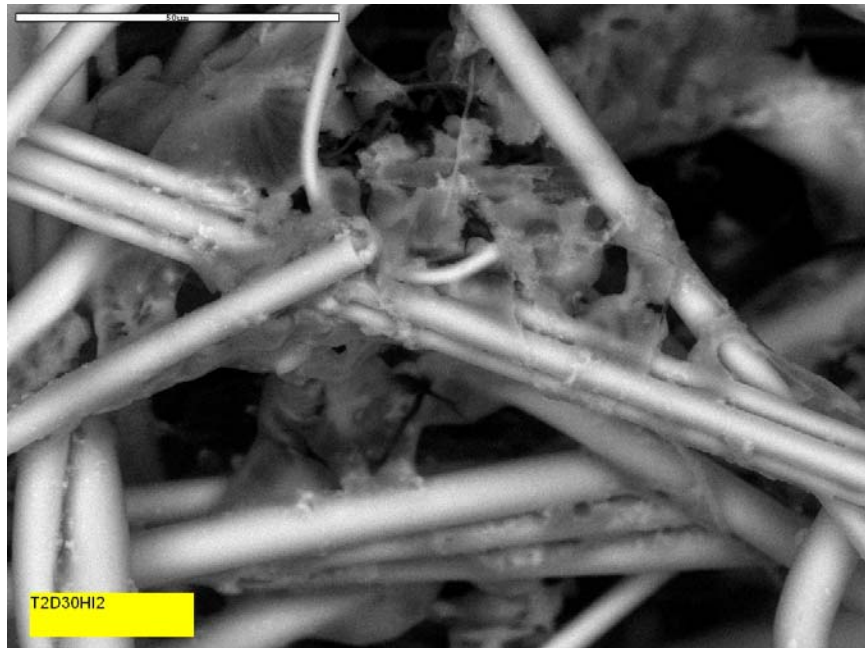


Figure D2-18. ESEM image of a higher magnification for a Test #2, Day-30 high-flow interior fiberglass sample. (T2D30HI2)

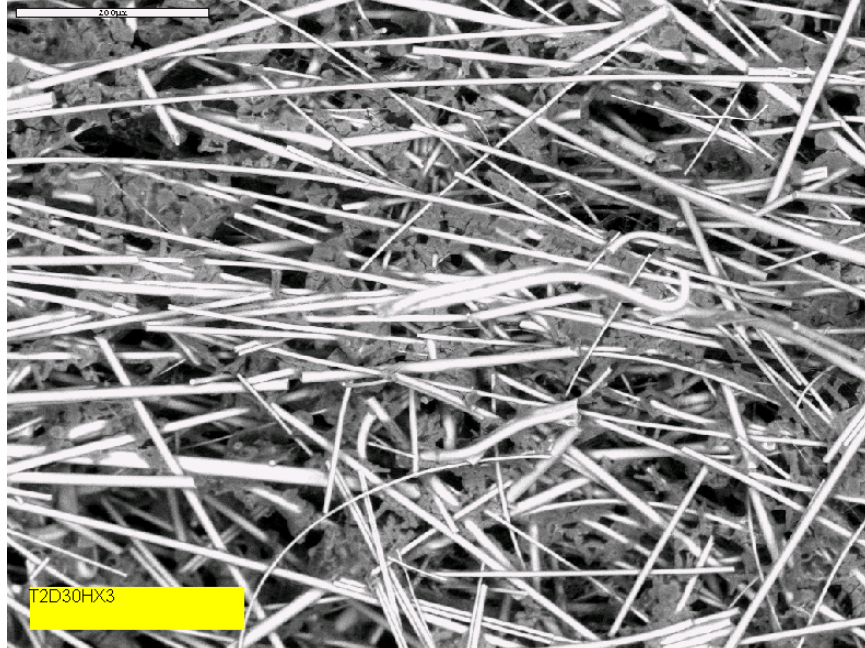


Figure D2-19. ESEM image for a Test #2, Day-30 high-flow exterior fiberglass sample. (T2D30HX3)

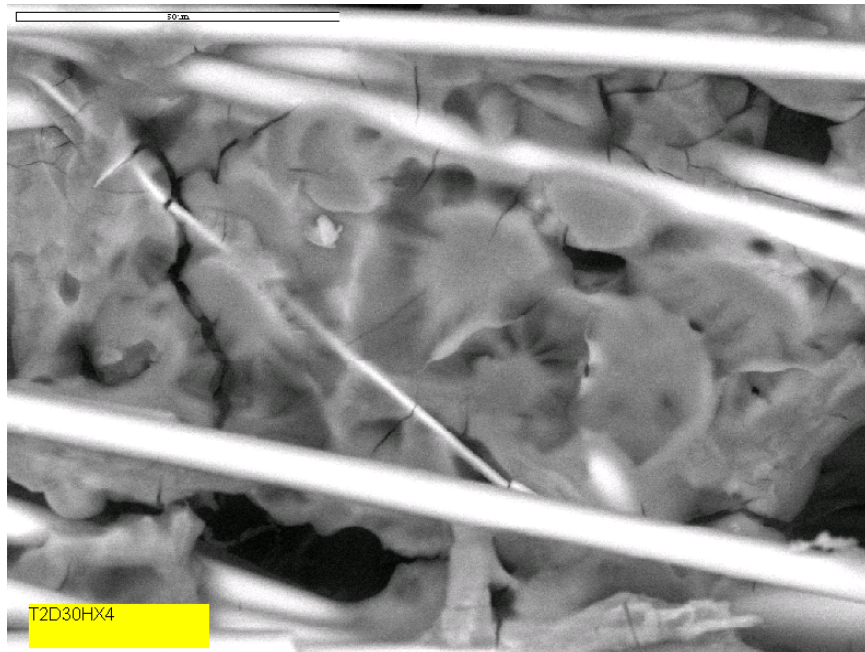


Figure D2-20. ESEM image of a higher magnification for a Test #2, Day-30 high-flow exterior fiberglass sample. (T2D30HX4)

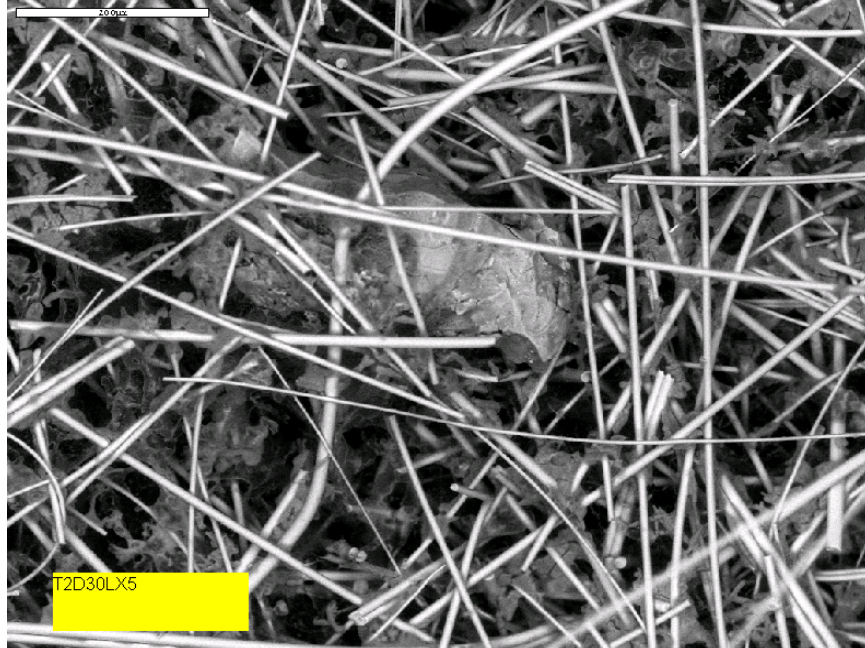


Figure D2-21. ESEM image for a Test #2, Day-30 low-flow exterior fiberglass sample. (T2D30LX5)

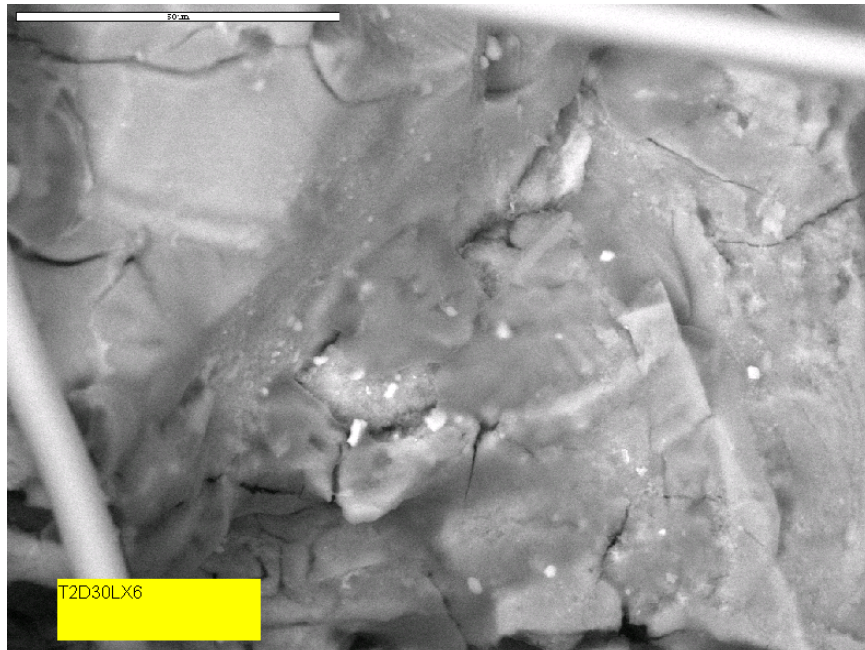


Figure D2-22. ESEM image of a higher magnification for a Test #2, Day-30 low-flow exterior fiberglass sample. (T2D30LX6)

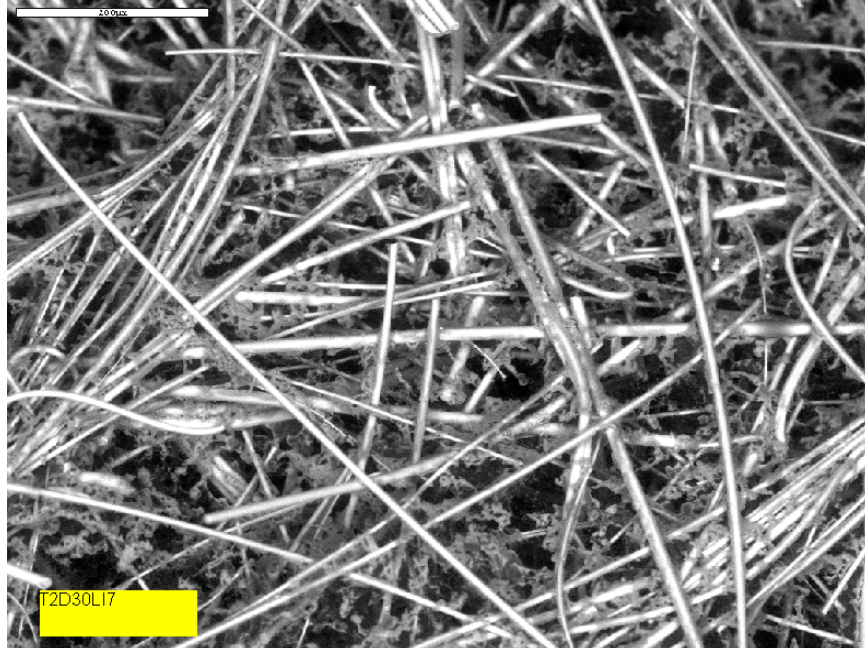


Figure D2-23. ESEM image for a Test #2, Day-30 low-flow interior fiberglass sample. (T2D30LI7)

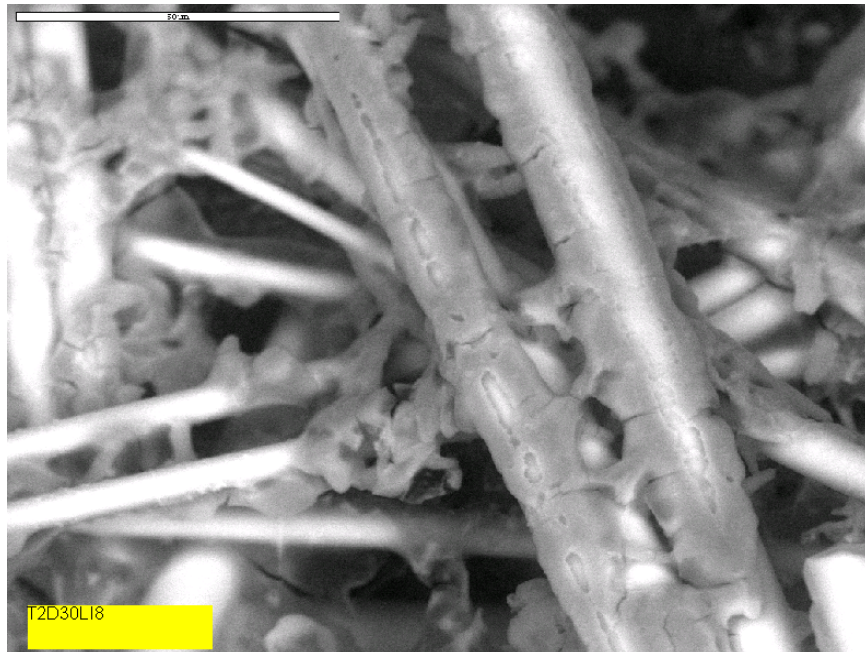


Figure D2-24. ESEM image of a higher magnification for a Test #2, Day-30 low-flow interior fiberglass sample. (T2D30LI8)

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