

## SUPPORTING INFORMATION

### Characterization of Per- and Polyfluorinated Alkyl Substances (PFAS) Present in Commercial Anti-Fog Products and Their In Vitro Adipogenic Activity

Nicholas J. Herkert<sup>1</sup>, Christopher D. Kassotis<sup>2</sup>, Sharon Zhang<sup>1</sup>, Yuling Han<sup>3</sup>, Vivek Francis Pulikkal<sup>3</sup>, Mei Sun<sup>3</sup>, P. Lee Ferguson<sup>1, 4</sup>, Heather M. Stapleton<sup>1\*</sup>

<sup>1</sup>Nicholas School of the Environment, Duke University, Box 90328, Durham, North Carolina 27708, United States

<sup>2</sup>Institute of Environmental Health Sciences and Department of Pharmacology, Wayne State University, Detroit, Michigan 48202, United States

<sup>3</sup>Department of Civil and Environmental Engineering, University of North Carolina at Charlotte, Charlotte, North Carolina 28223, United States

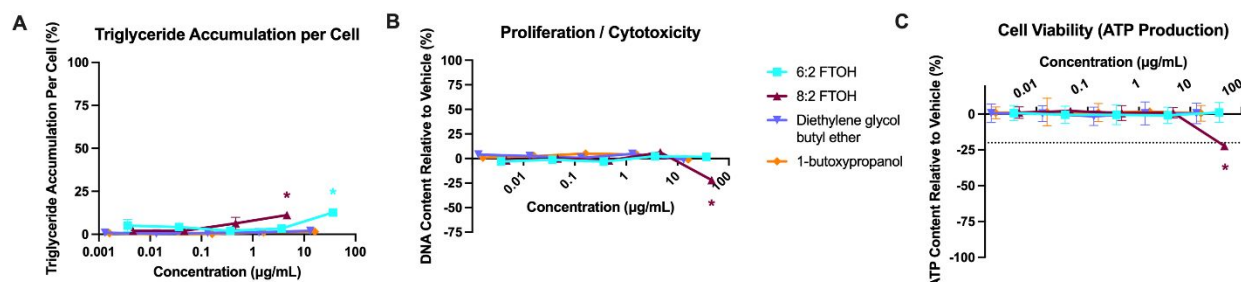
<sup>4</sup>Department of Civil and Environmental Engineering, Duke University, Durham, NC 27708, United States

#### Summary

The supporting information contains additional results for adipogenesis results (**Figure S1**); information about the anti-fog products (**Table S1**); chemical descriptors for PFAS compounds not observed in samples, including CAS number, IUPAC Name, SMILES, and INCHI-Key (**Table S2**); LC-MS summary results for ionic PFAS (**Table S3**); summary data for identified compounds, including molecular formulas, exact masses, observed massed and prevalent fragments (**Table S4**); chemical descriptors for identified PFAS compounds including CAS number, IUPAC Name, SMILES, and INCHI-Key (**Table S5**); average response ratios of identified compounds in the anti-fog products (**Table S6**); mean composition of 6:2 fluorotelomer ethoxymer distribution in commercial FTEO Mixture determined by HPLC-CAD analysis (**Table S7**); characteristics for the anti-fog sprays (**Table S8**); example results from HPLC-HRMS (**Figure S2 & Figure S3**); HPLC-CAD analysis of 6:2 FTEO mixture (**Figure S4**); GC-HRMS chromatograms for commercial FTEO mixtures (**Figure S5 & Figure S6**); and PCI spectra for identified compounds (**Figure S7 – Figure S52**). Clean PCI spectra were unable to be collected for 12:2 FTOH, 14:2 FTOH, 16:2 FTOH, all 14:2 FTEO compounds, and all 16:2 FTEO compounds due to low abundances or inferences.

## Additional Figures

### Anti-fog Solution and Component Adipogenesis Results



**Figure S1:** Adipogenesis results are presented for the two non-fluorinated additives (diethylene glycol butyl ether & 1-butoxypropanol) identified in anti-fog spray A. Percent triglyceride accumulation per cell (normalized to DNA content) in 3T3-L1 cells relative to maximal intra-assay response for rosiglitazone (left), increase (pre-adipocyte proliferation) or decrease (potential cytotoxicity) in DNA content relative to vehicle control (middle), increase or decrease in cell viability (ATP content) relative to vehicle control (right). Data presented as mean  $\pm$  SEM from three independent experiments.

### Additional Data Tables

**Table S1:** Summary information on the anti-fog products tested.

<u>Product Type</u>	<u>Sample ID</u>	<u>Brand Name</u>	<u>Ingredients Listed by the Manufacturer</u>	<u>Comments</u>
Anti-Fog Spray	Spray A	Gamer Advantage FogAway	fluoroaliphatic oxyethelene adduct, propyle glycol butyl ether, 2-(2-butoxyethoxy) ethanol	Made in USA
Anti-Fog Spray	Spray B	Recoppa	Non-Toxic surfactant, kathon, water	
Anti-Fog Spray	Spray C	Splaqua	No ingredients listed	Made in China
Anti-Fog Spray	Spray D	Optix 55 Fog GONE	No ingredients listed	Made in USA
Anti-Fog Cloth	Cloth A	Neatrition	No ingredients listed	Made in China
Anti-Fog Cloth	Cloth B	LifeArt	No ingredients listed	
Anti-Fog Cloth	Cloth C	EasyView	No ingredients listed	Made in Korea
Anti-Fog Cloth	Cloth D	ROTUS	No ingredients listed	Made in China
Anti-Fog Cloth	Cloth E	EYENID	No ingredients listed	Made in China



**Table S3:** LC results for ionic PFAS. The quantitated values are reported as mean (standard deviation) of triplicate measurements.

COMPOUND NAME	Abbrev.	CONCENTRATION (NG/ML)				CONCENTRATION (NG/G CLOTH)				
		Spray A	Spray B	Spray C	Spray D	Cloth A	Cloth B	Cloth C	Cloth D	Cloth E
PERFLUOROBUTANOIC ACID	PFBA	400.73 (202.67)	42.50 (1.64)	11.72 (0.50)	15.28 (2.15)	48.38 (10.81)	62.75 (7.89)	129.12 (26.50)	586.75 (141.72)	150.45 (49.15)
PERFLUOROPENTANOIC ACID	PFPeA	-- (--)	12.63 (0.44)	-- (--)	-- (--)	174.69 (22.12)	-- (--)	121.15 (35.62)	772.86 (168.79)	267.54 (97.74)
PERFLUOROHEXANOIC ACID	PFHxA	873.27 (83.18)	4.30 (0.22)	3.60 (0.42)	20.62 (0.65)	161.07 (24.31)	25.09 (3.64)	123.47 (23.73)	626.84 (169.22)	195.03 (73.17)
PERFLUOROHEPTANOIC ACID	PFHpA	36.22 (6.72)	1.05 (0.21)	0.77 (0.44)	0.41 (0.08)	776.96 (130.40)	62.87 (34.50)	241.49 (74.79)	635.07 (103.80)	129.47 (42.29)
PERFLUOROOCCTANOIC ACID	PFOA	-- (--)	-- (--)	-- (--)	-- (--)	594.26 (71.27)	-- (--)	85.31 (96.98)	-- (--)	31.92 (-- )
PERFLUORONONANOIC ACID	PFNA	-- (--)	-- (--)	-- (--)	-- (--)	69.89 (8.80)	-- (--)	-- (--)	-- (--)	-- (--)
PERFLUORODECANOIC ACID	PFDA	-- (--)	-- (--)	-- (--)	-- (--)	191.83 (28.40)	3.81 (--)	-- (--)	0.82 (0.49)	-- (--)
PERFLUOROUNDECANOIC ACID	PFUnA	-- (--)	-- (--)	-- (--)	-- (--)	13.62 (1.97)	-- (--)	-- (--)	-- (--)	-- (--)
PERFLUORODODECANOIC ACID	PFDoDA	7.00 (--)	-- (--)	-- (--)	-- (--)	41.98 (3.98)	0.52 (0.22)	-- (--)	-- (--)	1.07 (0.20)
PERFLUOROBUTANESULFONIC ACID	PFBS	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
PERFLUOROPENTANESULFONIC ACID	PFPeS	0.97 (0.76)	0.01 (0.02)	0.13 (0.19)	0.02 (0.00)	0.07 (0.06)	0.55 (0.10)	0.05 (0.04)	0.09 (0.06)	0.08 (0.06)
PERFLUOROHEXANESULFONIC ACID	PFHxS	-- (--)	0.65 (--)	-- (--)	-- (--)	-- (--)	-- (--)	4.13 (--)	-- (--)	-- (--)
PERFLUOROHEPTANESULFONIC ACID	PFHpS	3.80 (1.31)	0.03 (0.04)	-- (--)	-- (--)	0.14 (--)	-- (--)	0.05 (--)	0.10 (0.02)	0.05 (0.02)
PERFLUOROOCCTANESULFONIC ACID	PFOS	-- (--)	-- (--)	0.17 (0.07)	0.29 (0.22)	0.73 (0.33)	-- (--)	-- (--)	-- (--)	0.40 (0.04)

<b>PERFLUORONONANESULFONIC ACID</b>	<b>PFNS</b>	1.77 (0.45)	0.01 (0.01)	0.02 (0.01)	-- (--)	0.12 (0.10)	-- (--)	-- (--)	0.10 (0.06)	0.11 (0.05)
<b>PERFLUORODECANESULFONIC ACID</b>	<b>PFDS</b>	5.60 (3.04)	0.03 (0.02)	0.01 (--)	-- (--)	-- (--)	-- (--)	0.32 (0.11)	0.17 (0.11)	0.15 (0.05)
<b>PERFLUORODODECANESULFONIC ACID</b>	<b>PFDoS</b>	13.43 (9.87)	0.05 (0.01)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
<b>PERFLUORO-2-PROPOXYPROPANOIC ACID</b>	<b>GenX</b>	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
<b>4:2 FLUOROTELOMER SULFONIC ACID</b>	<b>4:2 FTS</b>	3.28 (1.91)	0.09 (0.01)	0.02 (0.00)	0.03 (0.01)	0.61 (0.05)	-- (--)	0.10 (0.01)	0.41 (0.20)	0.25 (0.06)
<b>6:2 FLUOROTELOMER SULFONIC ACID</b>	<b>6:2 FTS</b>	19.23 (5.40)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	0.93 (0.19)	52.84 (13.45)	0.14 (--)
<b>SODIUM BIS(1H, 1H,2H,2H-PERFLUORODECYL) PHOSPHATE</b>	<b>8:2diPAP</b>	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
<b>SODIUM BIS(1H, 1H,2H,2H-PERFLUOROOCYL) PHOSPHATE</b>	<b>6:2diPAP</b>	-- (--)	-- (--)	-- (--)	-- (--)	0.97 (--)	-- (--)	-- (--)	-- (--)	-- (--)
<b>SODIUM (1H, 1H,2H,2H-PERFLUOROOCYL-1H,1H,2H,2H-PERFLUORODECYL) PHOSPHATE</b>	<b>6:2/8:2diPAP</b>	-- (--)	-- (--)	-- (--)	-- (--)	1.96 (0.96)	-- (--)	-- (--)	-- (--)	-- (--)
<b>3,3,4,4,5,5,6,6,7,7,8,8,8-TRIDECAFLUOROOCANOIC ACID</b>	<b>6:2 FTCA</b>	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
<b>2H,2H-PERFLUORODECANOIC ACID</b>	<b>8:2 FTCA</b>	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
<b>2H,2H,3H,3H-PERFLUOROOCANOIC ACID</b>	<b>5:3 FTCA</b>	5.33 (4.98)	0.34 (0.22)	0.03 (0.02)	0.04 (0.03)	0.24 (0.26)	0.61 (0.20)	0.42 (0.20)	2.41 (0.37)	48.25 (13.85)
<b>2H,2H,3H,3H-PERFLUORODECANOIC ACID</b>	<b>7:3 FTCA</b>	-- (--)	0.01 (0.00)	0.03 (0.01)	-- (--)	6.77 (1.67)	0.14 (0.00)	0.11 (--)	0.13 (--)	0.13 (--)
<b>PERFLUOROOCANESULFONAMIDOACETIC ACID</b>	<b>FOSAA</b>	-- (--)	-- (--)	2.61 (1.16)	-- (--)	8.79 (--)	-- (--)	-- (--)	-- (--)	-- (--)

**Table S4:** Summary GC-HRMS data for all identified PFAS compounds in the anti-fog spray and cloth products analyzed including retention times, molecular formulas, exact masses, observed massed and prevalent fragments.

Compound	Retention Time	Formula	Exact Mass	Observed Mass	Fragment 1	Fragment 2	Fragment 3	Fragment 4	Fragment 5
<b>6:2FTOH</b>	10	C8H5O1F13	364.013279	365.021104	327.004311	na	na	na	na
<b>8:2FTOH</b>	11.91	C10H5O1F17	464.006891	465.014716	426.997923	na	na	na	na
<b>10:2FTOH</b>	13.49	C12H5O1F21	564.000503	565.008328	526.991535	na	na	na	na
<b>12:2-FTOH</b>	14.86	C14H5O1F25	663.994115	665.00194	626.985147	na	na	na	na
<b>14:2-FTOH</b>	15.89	C16H5O1F29	763.987727	764.995552	726.978759	na	na	na	na
<b>16:2-FTOH</b>	16.69	C18H5O1F33	863.981339	864.989164	826.972371	na	na	na	na
<b>6:2 - 6:2 FLOUROTELOMER ETHER</b>	13.39	C16H8O1F26	710.015993	711.023818	327.004311	377.021104	na	na	na
<b>6:2 - 8:2 FLOUROTELOMER ETHER</b>	14.84	C18H8O1F30	810.009605	811.01743	477.014716	426.997923	na	na	na
<b>8:2 - 8:2 FLOUROTELOMER ETHER</b>	15.92	C20H8O1F34	910.003217	911.011042	477.014716	426.997923	377.021104	327.004311	na
<b>8:2 - 10:2 FLOUROTELOMER ETHER</b>	16.72	C22H8O1F38	1009.996829	1011.004654	577.008328	526.991535	477.014716	426.997923	na
<b>10:2 - 10:2 FLOUROTELOMER ETHER</b>	17.35	C24H8O1F42	1109.990441	1011.004654	577.008328	526.991535	na	na	na
<b>1,4-BIS(1H,1H,2H,2H-PERFLUOROOCOTYL) FUMARATE</b>	18.1	C20H10O4F26	808.016388	809.024213	445.010934	365.021104	327.004311	na	na
<b>6:2FTEO1</b>	13.3	C10H9O2F13	408.039494	409.047319	327.004311	365.021104	391.036754	na	na
<b>6:2FTEO2</b>	16.54	C12H13O3F13	452.065709	453.073534	327.004311	365.021104	391.036754	435.062969	na
<b>6:2FTEO3</b>	18.43	C14H17O4F13	496.091924	497.099749	327.004311	365.021104	391.036754	435.062969	na
<b>6:2FTEO4</b>	20.15	C16H21O5F13	540.118139	541.125964	327.004311	365.021104	391.036754	435.062969	479.089184
<b>6:2FTEO5</b>	21.92	C18H25O6F13	584.144354	585.152179	327.004311	365.021104	391.036754	435.062969	479.089184
<b>6:2FTEO6</b>	24.45	C20H29O7F13	628.170569	629.178394	327.004311	365.021104	391.036754	435.062969	479.089184
<b>6:2FTEO7</b>	29.75	C22H33O8F13	672.196784	673.204609	327.004311	365.021104	391.036754	435.062969	479.089184
<b>6:2FTEO8</b>	41.95	C24H37O9F13	716.222999	717.230824	327.004311	365.021104	391.036754	435.062969	479.089184
<b>6:2 - 6:2 FTEO1</b>	16.06	C18H12O2F26	754.042208	755.00903	327.004311	365.021104	na	na	na
<b>6:2 - 6:2 FTEO2</b>	17.62	C20H16O3F26	798.068423	799.03558	327.004311	365.021104	391.036754	435.062969	na
<b>6:2 - 6:2 FTEO3</b>	18.87	C22H20O4F26	842.094638	843.06177	327.004311	365.021104	391.036754	435.062969	na
<b>6:2 - 6:2 FTEO4</b>	20	C24H24O5F26	886.120853	887.08838	327.004311	365.021104	391.036754	435.062969	479.089184

<b>6:2 - 6:2 FTEO5</b>	21.31	C26H28O6F26	930.147068	931.11444	327.004311	365.021104	391.036754	435.062969	479.089184
<b>6:2 - 6:2 FTEO6</b>	22.74	C28H32O7F26	974.173283	975.14063	327.004311	365.021104	391.036754	435.062969	479.089184
<b>6:2 - 6:2 FTEO7</b>	25.28	C30H36O8F26	1018.199498	1019.16583	327.004311	365.021104	391.036754	435.062969	479.089184
<b>6:2 - 6:2 FTEO8</b>	30.69	C32H40O9F26	1062.225713	na	327.004311	365.021104	391.036754	435.062969	na
<b>8:2FTEO1</b>	14.36	C12H9O2F17	508.033106	509.040931	426.997923	465.014716	491.030366	na	na
<b>8:2FTEO2</b>	16.89	C14H13O3F17	552.059321	553.067146	426.997923	465.014716	491.030366	535.056581	na
<b>8:2FTEO3</b>	18.56	C16H17O4F17	596.085536	597.093361	426.997923	465.014716	491.030366	535.056581	na
<b>8:2FTEO4</b>	20.16	C18H21O5F17	640.111751	641.119576	426.997923	465.014716	491.030366	535.056581	579.082796
<b>8:2FTEO5</b>	21.84	C20H25O6F17	684.137966	685.145791	426.997923	465.014716	491.030366	535.056581	579.082796
<b>8:2FTEO6</b>	24.18	C22H29O7F17	728.164181	729.172006	426.997923	465.014716	491.030366	535.056581	579.082796
<b>8:2FTEO7</b>	29	C24H33O8F17	772.190396	773.198221	426.997923	465.014716	491.030366	535.056581	579.082796
<b>8:2FTEO8</b>	39.96	C26H37O9F17	816.216611	817.224436	426.997923	465.014716	491.030366	535.056581	579.082796
<b>10:2 FTEO1</b>	15.4	C14H9O2F21	608.026718	609.034543	526.991535	565.008328	591.023978	na	na
<b>10:2 FTEO2</b>	17.32	C16H13O3F21	652.052933	653.060758	526.991535	565.008328	591.023978	635.050193	na
<b>10:2 FTEO3</b>	18.77	C18H17O4F21	696.079148	697.086973	526.991535	565.008328	591.023978	635.050193	na
<b>10:2 FTEO4</b>	20.28	C20H21O5F21	740.105363	741.113188	526.991535	565.008328	591.023978	635.050193	679.076408
<b>10:2 FTEO5</b>	21.84	C22H25O6F21	784.131578	785.139403	526.991535	565.008328	591.023978	635.050193	679.076408
<b>10:2 FTEO6</b>	24.04	C24H29O7F21	828.157793	829.165618	526.991535	565.008328	591.023978	635.050193	679.076408
<b>10:2 FTEO7</b>	28.54	C26H33O8F21	872.184008	873.191833	526.991535	565.008328	591.023978	635.050193	679.076408
<b>10:2 FTEO8</b>	38.72	C28H37O9F21	916.210223	917.218048	526.991535	565.008328	591.023978	635.050193	679.076408
<b>12:2-FTEO1</b>	16.27	C16H9O2F25	708.02033	709.028155	626.985147	665.00194	691.01759	na	na
<b>12:2-FTEO2</b>	17.78	C18H13O3F25	752.046545	753.05437	626.985147	665.00194	691.01759	735.043805	na
<b>12:2-FTEO3</b>	19.06	C20H17O4F25	796.07276	797.080585	626.985147	665.00194	691.01759	735.043805	na
<b>12:2-FTEO4</b>	20.51	C22H21O5F25	840.098975	841.1068	626.985147	665.00194	691.01759	735.043805	779.07002
<b>12:2-FTEO5</b>	21.97	C24H25O6F25	884.12519	885.133015	626.985147	665.00194	691.01759	735.043805	779.07002
<b>12:2-FTEO6</b>	24.14	C26H29O7F25	928.151405	929.15923	626.985147	665.00194	691.01759	735.043805	779.07002
<b>12:2-FTEO7</b>	28.57	C28H33O8F25	972.17762	973.185445	626.985147	665.00194	691.01759	735.043805	779.07002
<b>12:2-FTEO8</b>	38.66	C30H37O9F25	1016.203835	1017.21166	626.985147	665.00194	691.01759	735.043805	779.07002
<b>14:2-FTEO1</b>	16.97	C18H9O2F29	808.013942	809.021767	726.978759	764.995552	791.011202	na	na



<b>14:2-FTEO2</b>	18.25	C20H13O3F29	852.040157	853.047982	726.978759	764.995552	791.011202	835.037417	na
<b>14:2-FTEO3</b>	19.4	C22H17O4F29	896.066372	897.074197	726.978759	764.995552	791.011202	835.037417	na
<b>14:2-FTEO4</b>	20.81	C24H21O5F29	940.092587	941.100412	726.978759	764.995552	791.011202	835.037417	879.063632
<b>14:2-FTEO5</b>	22.22	C26H25O6F29	984.118802	985.126627	726.978759	764.995552	791.011202	835.037417	879.063632
<b>14:2-FTEO6</b>	24.38	C28H29O7F29	1028.145017	1029.152842	726.978759	764.995552	791.011202	835.037417	879.063632
<b>14:2-FTEO7</b>	28.99	C30H33O8F29	1072.171232	1073.179057	726.978759	764.995552	791.011202	835.037417	879.063632
<b>14:2-FTEO8</b>	39.46	C32H37O9F29	1116.197447	1117.205272	726.978759	764.995552	791.011202	835.037417	879.063632
<b>16:2-FTEO1</b>	17.58	C20H9O2F33	908.007554	909.015379	826.972371	864.989164	891.004814	na	na
<b>16:2-FTEO2</b>	18.72	C22H13O3F33	952.033769	953.041594	826.972371	864.989164	891.004814	935.031029	na
<b>16:2-FTEO3</b>	19.82	C24H17O4F33	996.059984	997.067809	826.972371	864.989164	891.004814	935.031029	na
<b>16:2-FTEO4</b>	21.15	C26H21O5F33	1040.086199	1041.094024	826.972371	864.989164	891.004814	935.031029	979.057244
<b>16:2-FTEO5</b>	22.54	C28H25O6F33	1084.112414	1085.120239	826.972371	864.989164	891.004814	935.031029	979.057244
<b>16:2-FTEO6</b>	25.09	C30H29O7F33	1128.138629	1129.146454	826.972371	864.989164	891.004814	935.031029	979.057244
<b>16:2-FTEO7</b>	30.12	C32H33O8F33	1172.164844	1173.172669	826.972371	864.989164	891.004814	935.031029	979.057244
<b>16:2-FTEO8</b>	41.68	C34H37O9F33	1216.191059	1217.198884	826.972371	864.989164	891.004814	935.031029	979.057244







**Table S6:** Average response ratios (analyte response normalized to 13C 8:2 FTOH response) for all identified PFAS compounds in the anti-fog spray, anti-fog cloth products, and commercial mixtures analyzed via HR-GCMS analysis.

COMPOUND	SPRAY A	SPRAY B	SPRAY C	SPRAY D	CLOTH A	CLOTH B	CLOTH C	CLOTH D	CLOTH E	FTEO MIXTURE	ZONYL FSN-100
6:2FTOH	134,873	405	41	43	5	48	514	76	93	106	10
8:2FTOH	--	--	--	--	1,167	--	--	--	--	--	7
10:2FTOH	--	--	--	--	483	--	--	--	--	--	15
12:2-FTOH	--	--	--	--	33	--	--	--	--	--	2
14:2-FTOH	--	--	--	--	2	--	--	--	--	--	0
16:2-FTOH	--	--	--	--	0	--	--	--	--	--	0
6:2 - 6:2 Flourotelomer Ether	--	379	236	247	16	2,026	9,680	2,010	2,463	443	233
6:2 - 8:2 Flourotelomer Ether	--	--	--	--	14	--	--	--	--	--	348
8:2 - 8:2 Flourotelomer Ether	--	--	--	--	810	--	--	--	--	--	280
8:2 - 10:2 Flourotelomer Ether	--	--	--	--	135	--	--	--	--	--	175
10:2 - 10:2 Flourotelomer Ether	--	--	--	--	20	--	--	--	--	--	83
1,4-bis(1H,1H,2H,2H-Perfluorooctyl) fumarate	48,896	--	--	--	--	--	--	--	--	--	--
6:2FTEO1	242	30	2	2	1	96	541	372	734	8	5
6:2FTEO2	1,225	57	10	10	0	131	876	1,622	1,915	26	1
6:2FTEO3	2,450	91	14	14	1	432	3,581	5,139	3,602	83	2
6:2FTEO4	4,905	90	42	40	5	1,478	16,054	16,437	6,825	270	7
6:2FTEO5	9,328	172	333	307	14	3,860	52,963	44,746	12,585	744	26
6:2FTEO6	8,333	165	198	196	9	4,237	50,900	44,630	12,399	853	41
6:2FTEO7	4,152	111	184	179	4	2,701	21,128	17,433	6,274	544	44
6:2FTEO8	193	68	146	148	1	1,467	9,524	8,402	3,429	282	46
6:2 - 6:2 FTEO1	--	6	--	--	--	--	--	16	21	--	--
6:2 - 6:2 FTEO2	--	7	--	--	--	--	--	54	68	--	--
6:2 - 6:2 FTEO3	--	11	--	--	--	--	--	137	146	--	--
6:2 - 6:2 FTEO4	--	9	--	--	--	--	--	150	183	--	--
6:2 - 6:2 FTEO5	--	13	--	--	--	--	--	103	283	--	--

6:2 - 6:2 FTEO6	--	11	--	--	--	--	--	74	313	--	--
6:2 - 6:2 FTEO7	--	5	--	--	--	--	--	31	172	--	--
6:2 - 6:2 FTEO8	--	0	--	--	--	--	--	1	51	--	--
8:2FTEO1	--	--	--	--	252	--	--	--	--	--	1
8:2FTEO2	--	--	--	--	403	--	--	--	--	--	1
8:2FTEO3	--	--	--	--	950	--	--	--	--	--	3
8:2FTEO4	--	--	--	--	2,079	--	--	--	--	--	8
8:2FTEO5	--	--	--	--	4,086	--	--	--	--	--	22
8:2FTEO6	--	--	--	--	3,485	--	--	--	--	--	39
8:2FTEO7	--	--	--	--	1,689	--	--	--	--	--	41
8:2FTEO8	--	--	--	--	695	--	--	--	--	--	40
10:2 FTEO1	--	--	--	--	25	--	--	--	--	--	0
10:2 FTEO2	--	--	--	--	65	--	--	--	--	--	1
10:2 FTEO3	--	--	--	--	164	--	--	--	--	--	2
10:2 FTEO4	--	--	--	--	421	--	--	--	--	--	5
10:2 FTEO5	--	--	--	--	915	--	--	--	--	--	14
10:2 FTEO6	--	--	--	--	455	--	--	--	--	--	19
10:2 FTEO7	--	--	--	--	230	--	--	--	--	--	22
10:2 FTEO8	--	--	--	--	127	--	--	--	--	--	22
12:2-FTEO1	--	--	--	--	3	--	--	--	--	--	0
12:2-FTEO2	--	--	--	--	9	--	--	--	--	--	0
12:2-FTEO3	--	--	--	--	21	--	--	--	--	--	1
12:2-FTEO4	--	--	--	--	49	--	--	--	--	--	2
12:2-FTEO5	--	--	--	--	80	--	--	--	--	--	6
12:2-FTEO6	--	--	--	--	136	--	--	--	--	--	11
12:2-FTEO7	--	--	--	--	46	--	--	--	--	--	11
12:2-FTEO8	--	--	--	--	25	--	--	--	--	--	11
14:2-FTEO1	--	--	--	--	1	--	--	--	--	--	0
14:2-FTEO2	--	--	--	--	1	--	--	--	--	--	0

14:2-FTEO3	--	--	--	--	3	--	--	--	--	--	0
14:2-FTEO4	--	--	--	--	6	--	--	--	--	--	1
14:2-FTEO5	--	--	--	--	9	--	--	--	--	--	3
14:2-FTEO6	--	--	--	--	9	--	--	--	--	--	4
14:2-FTEO7	--	--	--	--	6	--	--	--	--	--	5
14:2-FTEO8	--	--	--	--	3	--	--	--	--	--	5
16:2-FTEO1	--	--	--	--	--	--	--	--	--	--	0
16:2-FTEO2	--	--	--	--	0	--	--	--	--	--	0
16:2-FTEO3	--	--	--	--	0	--	--	--	--	--	0
16:2-FTEO4	--	--	--	--	1	--	--	--	--	--	0
16:2-FTEO5	--	--	--	--	1	--	--	--	--	--	1
16:2-FTEO6	--	--	--	--	0	--	--	--	--	--	1
16:2-FTEO7	--	--	--	--	0	--	--	--	--	--	2
16:2-FTEO8	--	--	--	--	--	--	--	--	--	--	1

**Table S7:** Mean composition of 6:2 FTEO ethoxymers in commercial FTEO Mixture determined by HPLC-CAD analysis.

<b>COMPOUND</b>	<b>MEAN % COMPOSITION IN FTEO MIXTURE (SD)</b>
<b>6:2 FTEO1</b>	N.A.
<b>6:2 FTEO2</b>	0.08 (0.01)
<b>6:2 FTEO3</b>	0.35 (0.07)
<b>6:2 FTEO4</b>	3.77 (0.04)
<b>6:2 FTEO5</b>	12.52 (0.35)
<b>6:2 FTEO6</b>	16.45 (0.38)
<b>6:2 FTEO7</b>	16.40 (0.32)
<b>6:2 FTEO8</b>	14.24 (0.26)
<b>6:2 FTEO9</b>	11.25 (0.24)
<b>6:2 FTEO10</b>	8.05 (0.18)
<b>6:2 FTEO11</b>	5.04 (0.05)
<b>6:2 FTEO12</b>	2.95 (0.08)
<b>6:2 FTEO13</b>	1.64 (0.05)
<b>TOTAL:</b>	92.74 (1.85)

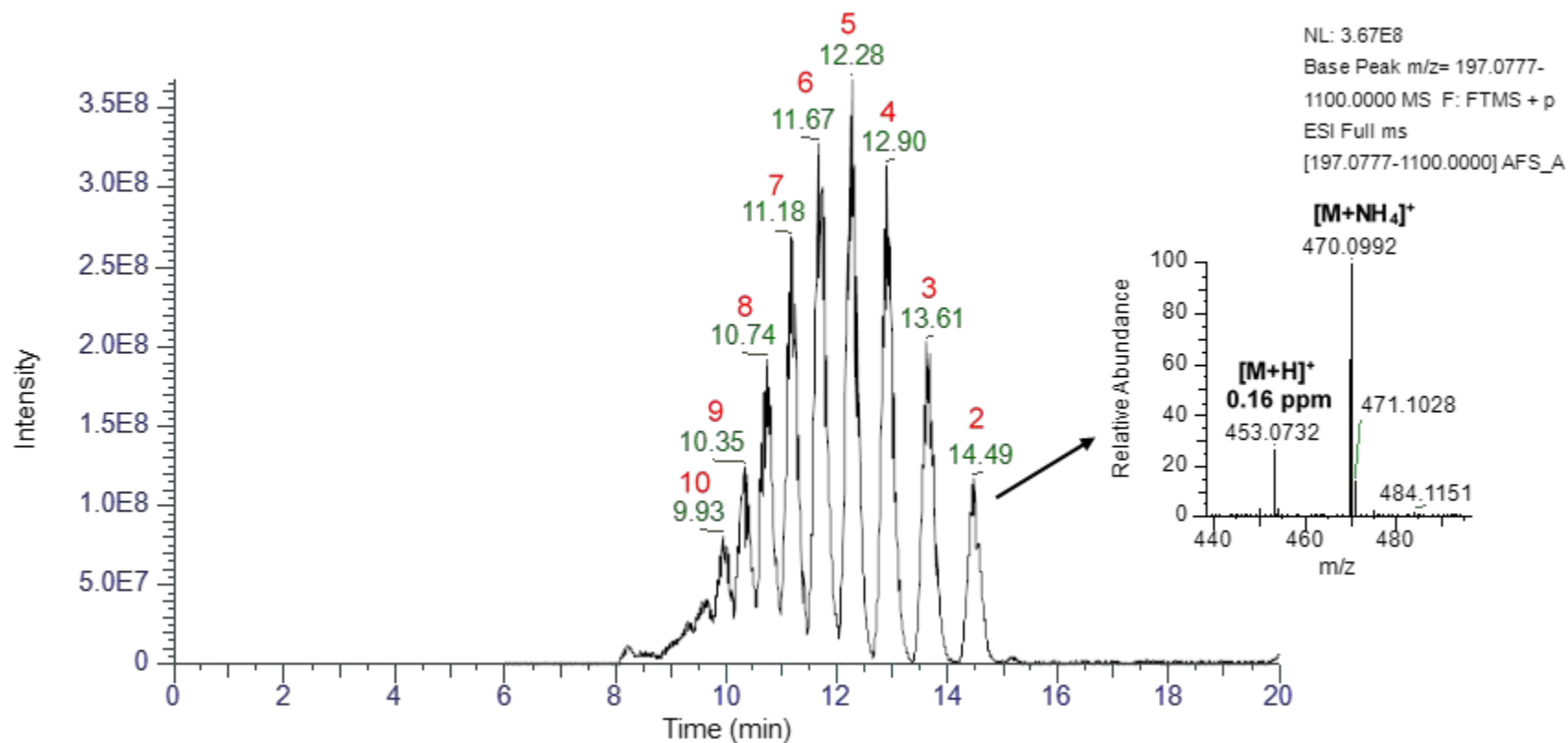


**Table S8:** 6:2 FTOH exposure potential for the anti-fog sprays.

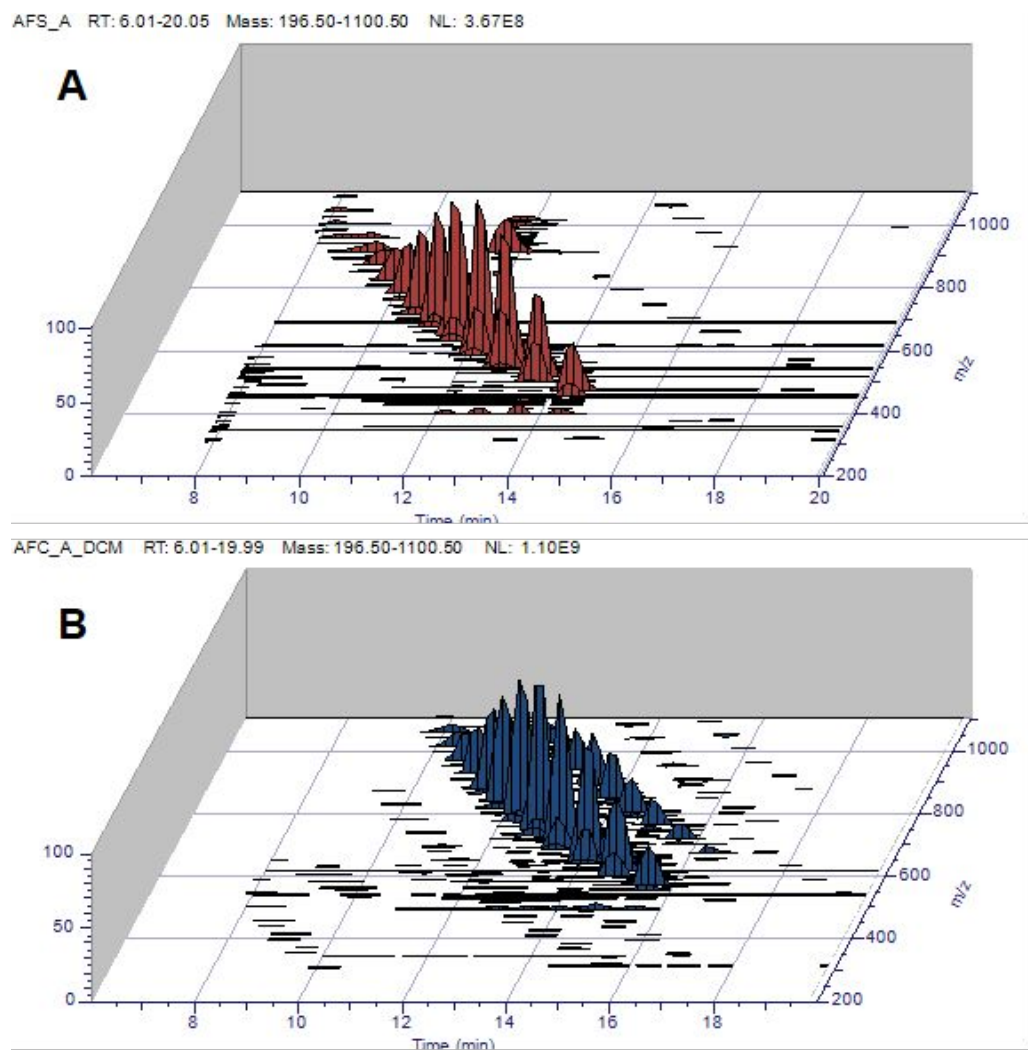
<b>Spray ID</b>	<b>Solution Density (g/mL)</b>	<b>Solution Mass per use (g/spray)</b>	<b>Potential Exposure to FTEOs and FTOHs per use (µg/use)</b>
<b>A</b>	0.9509	0.1335	3500
<b>B</b>	0.9762	0.0890	29.8
<b>C</b>	0.9639	0.1451	79.6
<b>D</b>	0.9896	0.1641	93.8

## Supporting HPLC Figures

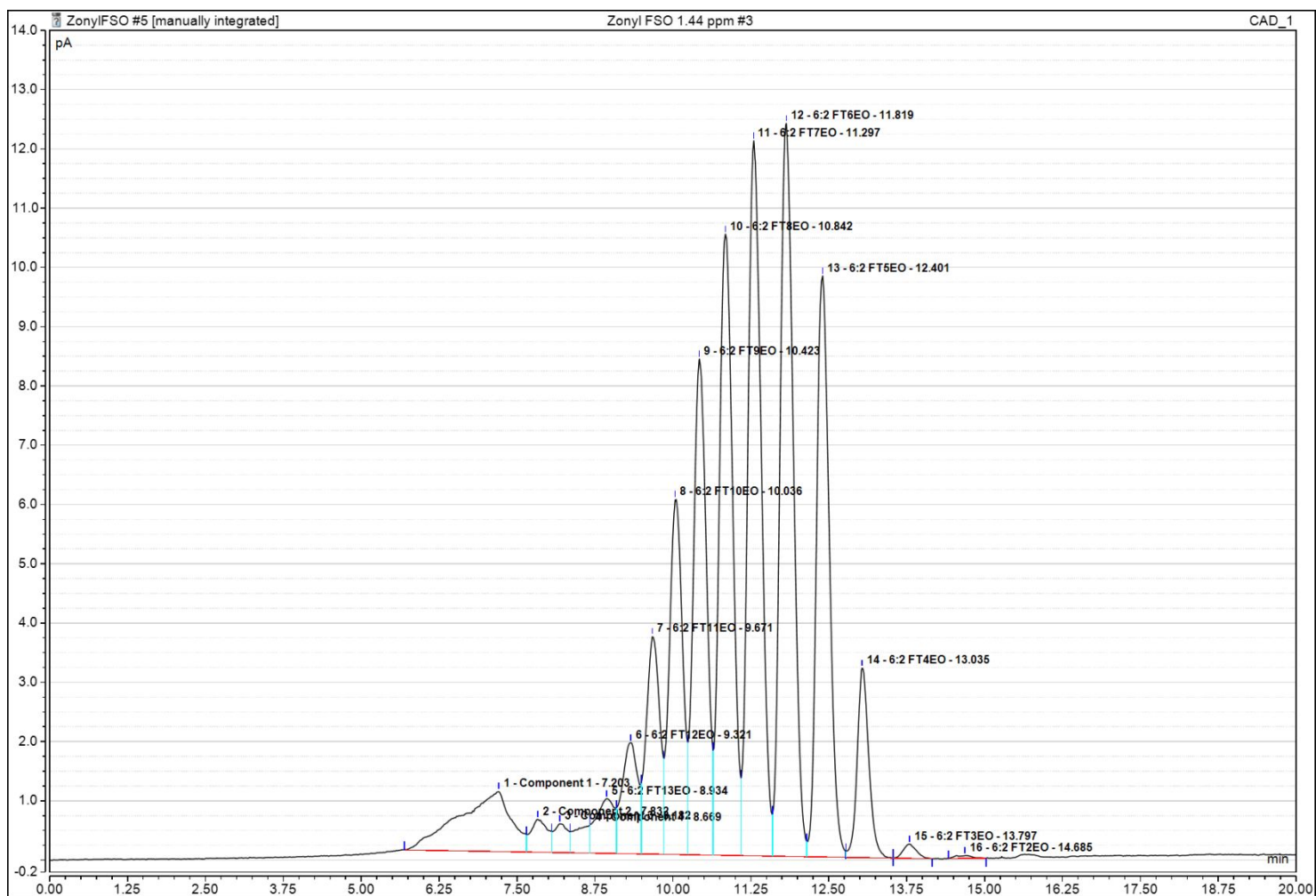
RT :0.00-20.00



**Figure S2:** HPLC-HRMS base-peak chromatogram from analysis of anti-fog spray “A” showing 6:2 FTEO elution series. Red numbers indicate ethoxyl chain lengths (e.g. “2” = FT2EO). Inset shows example mass spectrum for FT2EO peak, illustrating formation of  $[M+H]^+$  and  $[M+NH_4]^+$  ions and measurement with 0.16 ppm mass accuracy.

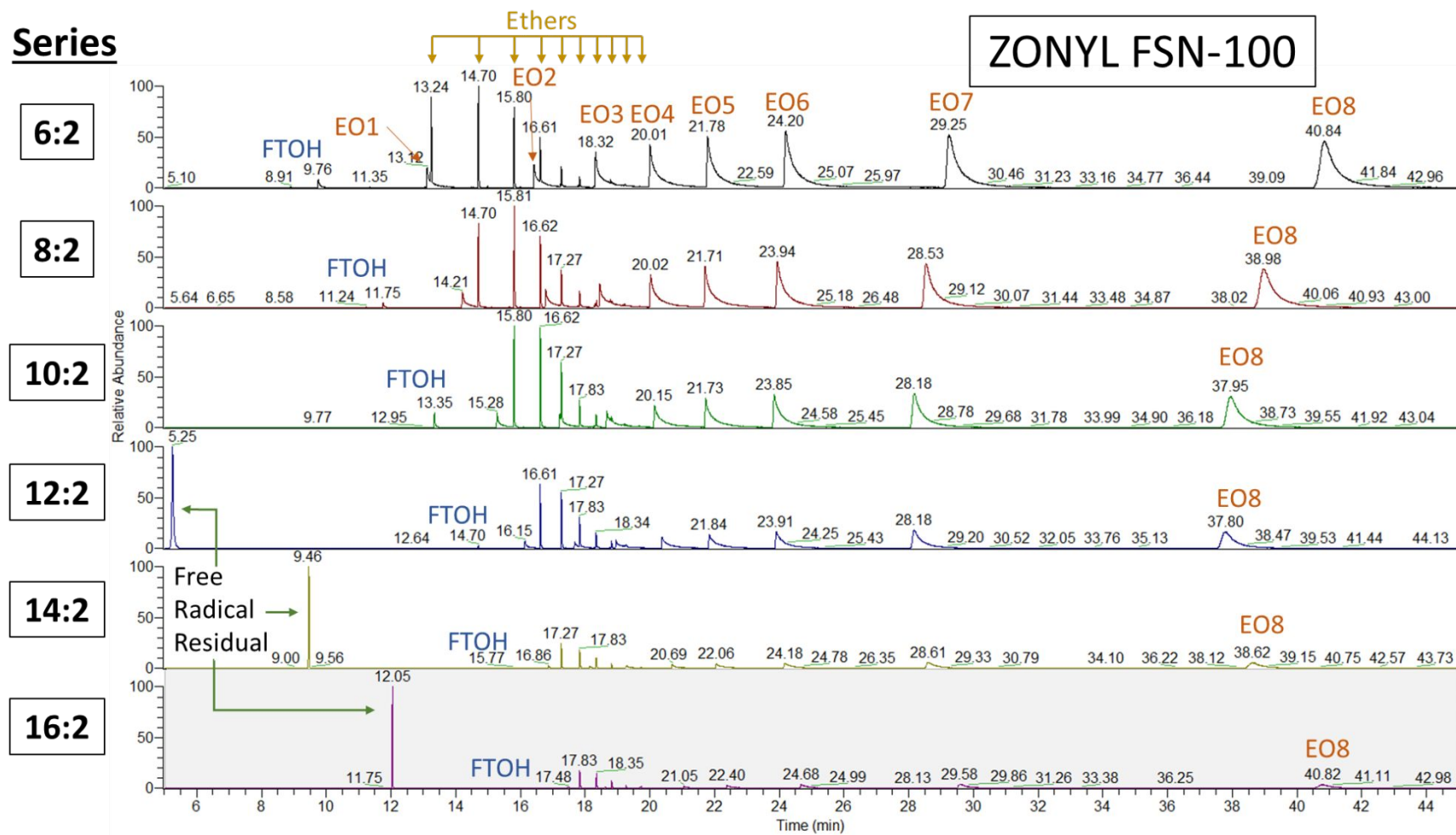


**Figure S3:** HPLC-HRMS map displays from analysis of (A) anti-fog spray “A” showing 6:2 FTEO elution series and (B) anti-fog cloth extract “A” showing complex mixture of multiple n:2 FTEO series eluting at later retention times and higher m/z.



**Figure S4:** HPLC-CAD analysis of 6:2 FTEO fluorosurfactant formulation showing elution of individual ethoxymers under applied separation conditions.

## Supporting GC-HRMS Figures



**Figure S5:** GC-HRMS Characterization of ZONYL-FSN 100 commercial mixture.

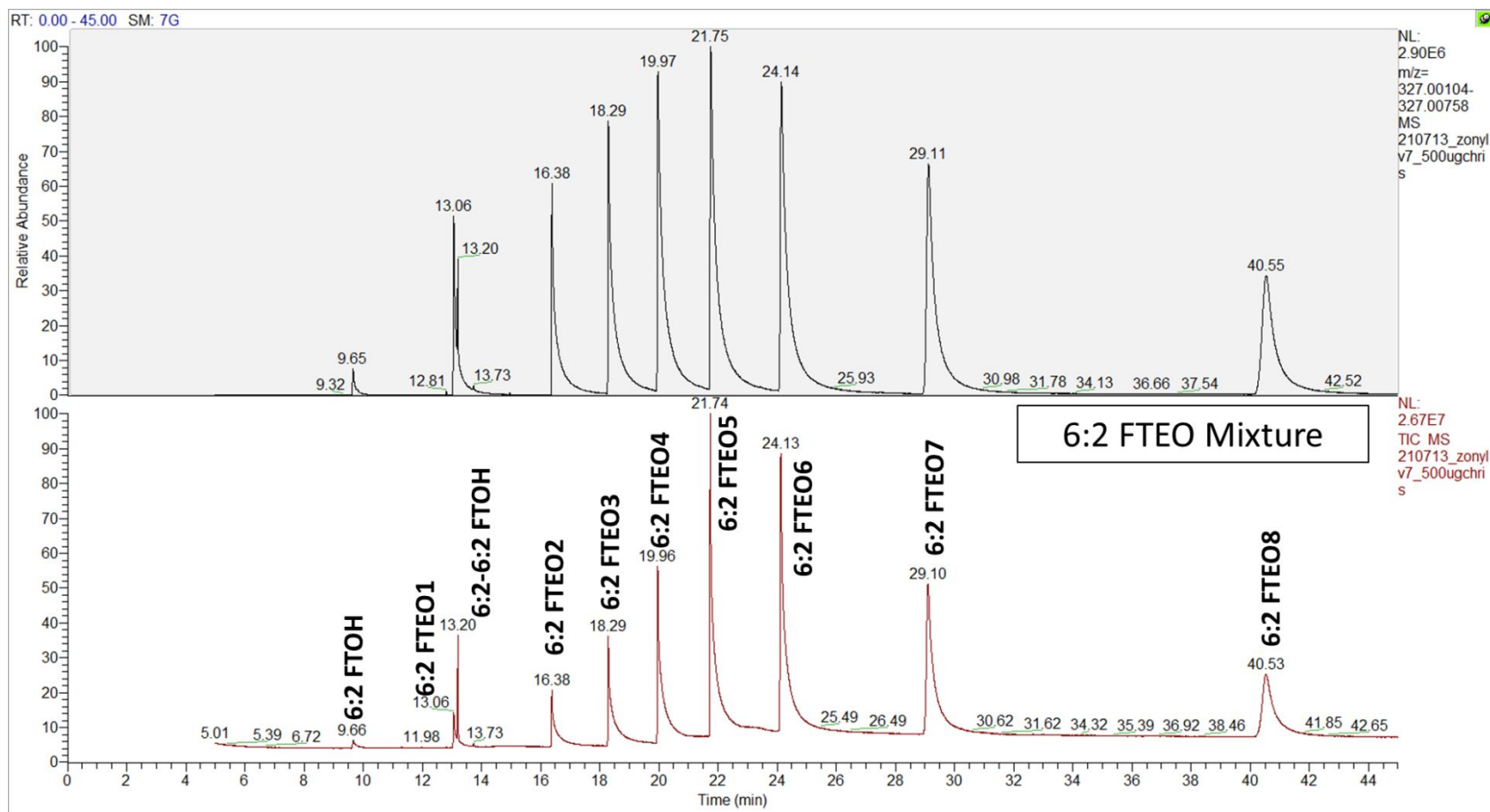


Figure S6: GC-HRMS Characterization of 6:2 FTEO commercial mixture.

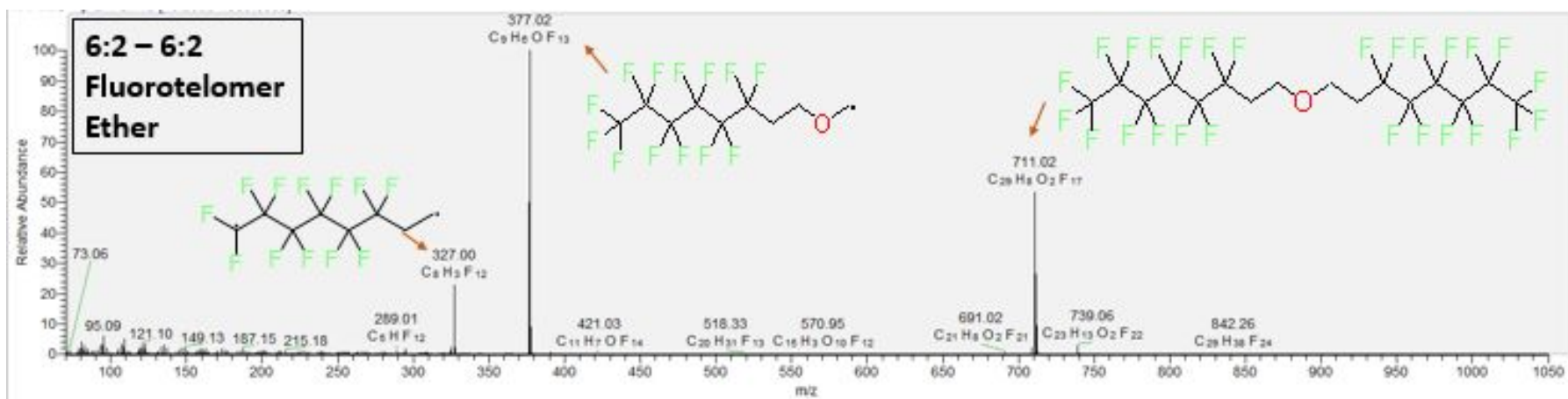


Figure S7: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6-tridecafluoro-8-((3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)oxy)octane

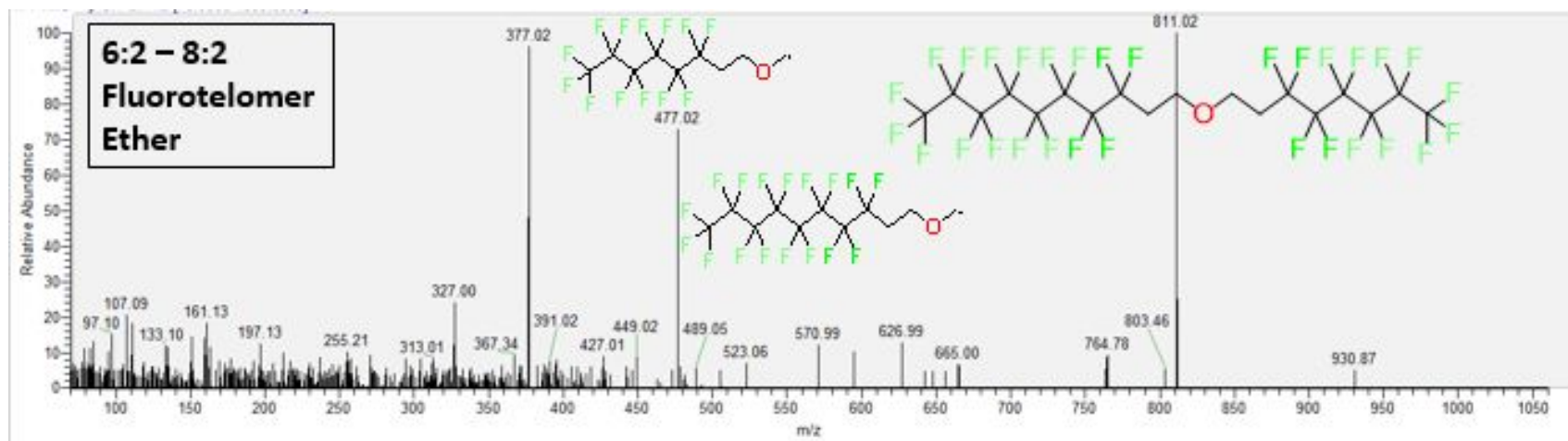


Figure S8: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8-heptadecafluoro-10-((3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)oxy)decane



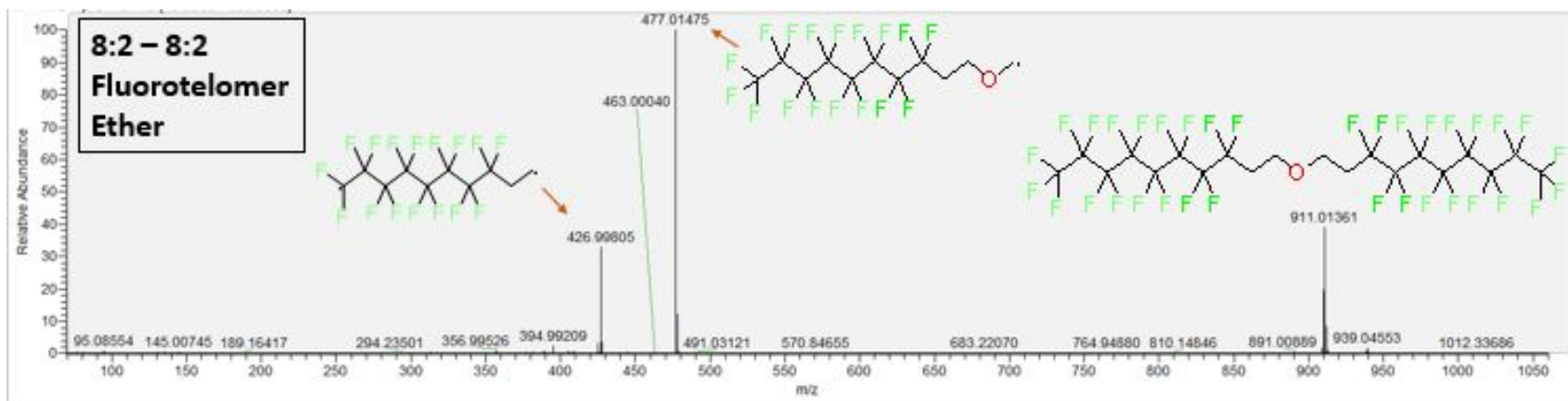


Figure S9: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8-heptadecafluoro-10-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)oxy)decane

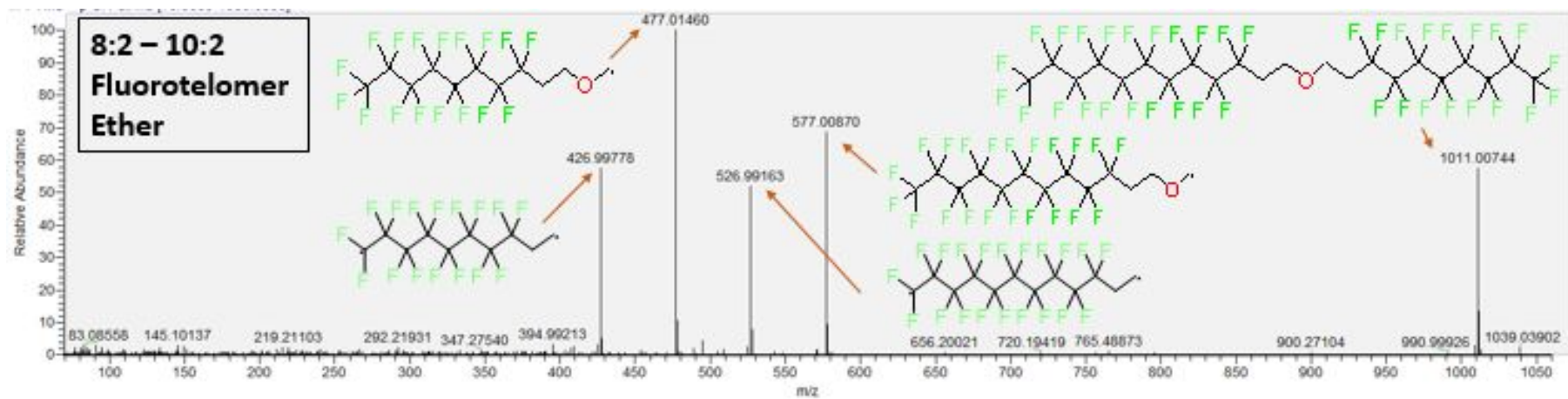


Figure S10: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-henicosafuoro-12-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)oxy)dodecane



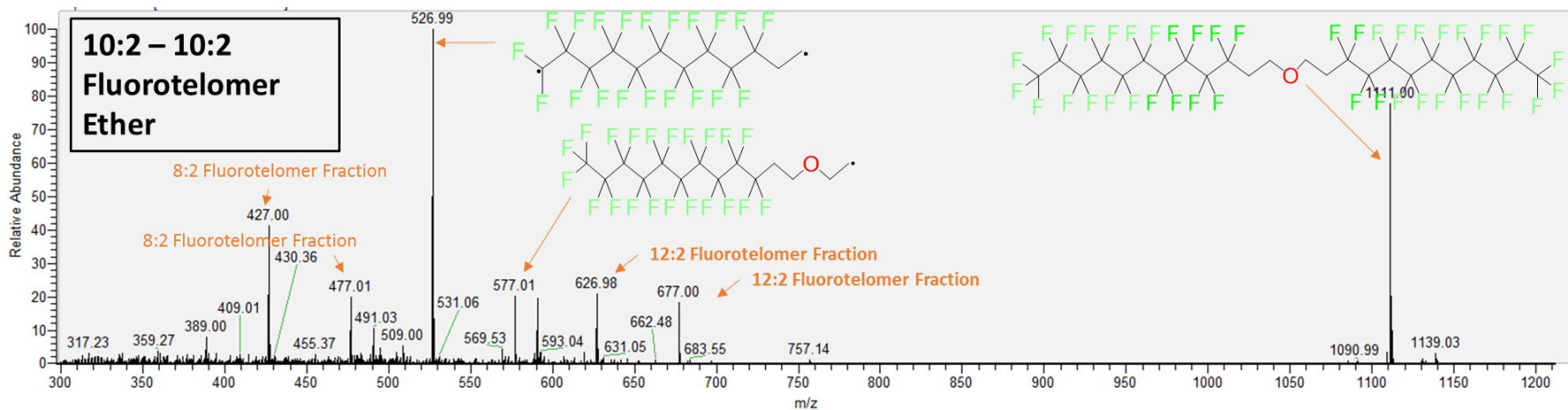


Figure S11: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-henicosafluoro-12-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-henicosafluorododecyl)oxy)dodecane. There is evidence that 10:2-10:2 fluorotelomer ether is coeluting with 8:2-12:2 Fluorotelomer ether, which shares the same exact mass.

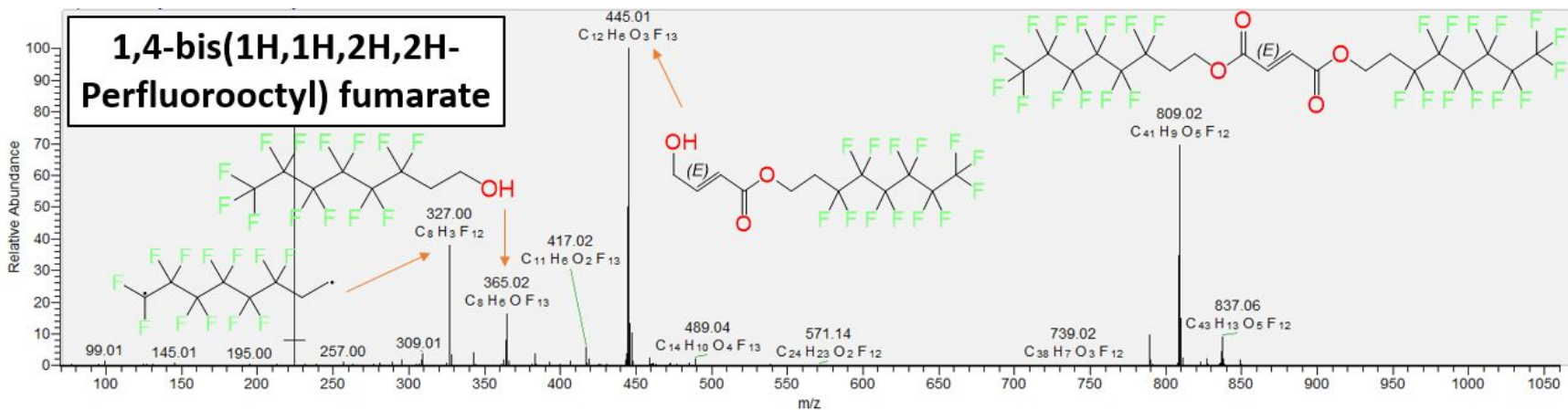


Figure S12: Spectra for 1,4-bis(1H,1H,2H,2H-Perfluorooctyl) fumarate

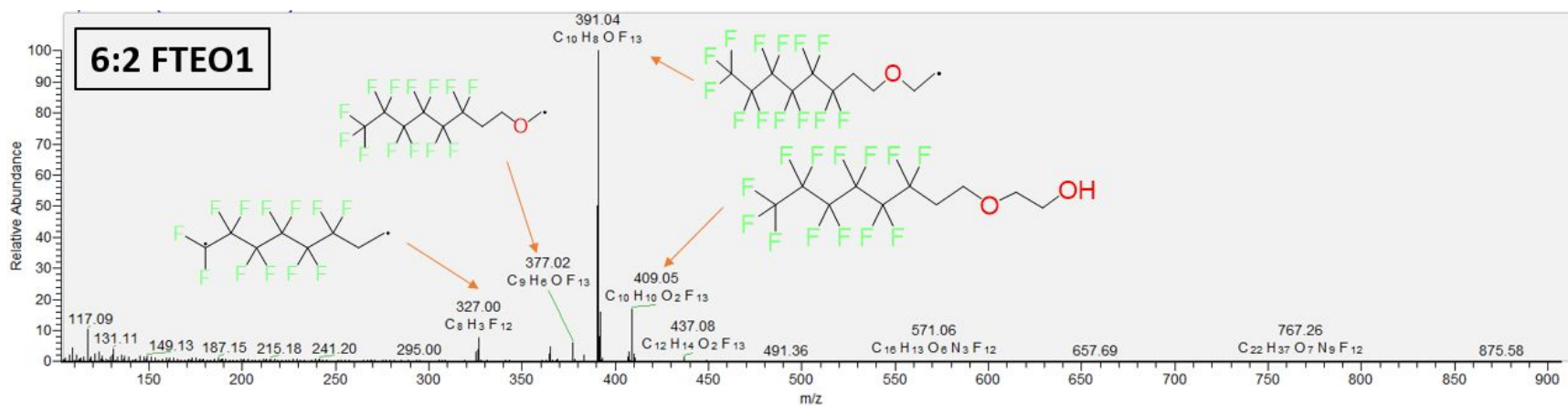


Figure S13: Spectra for 2-((3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)oxy)ethan-1-ol

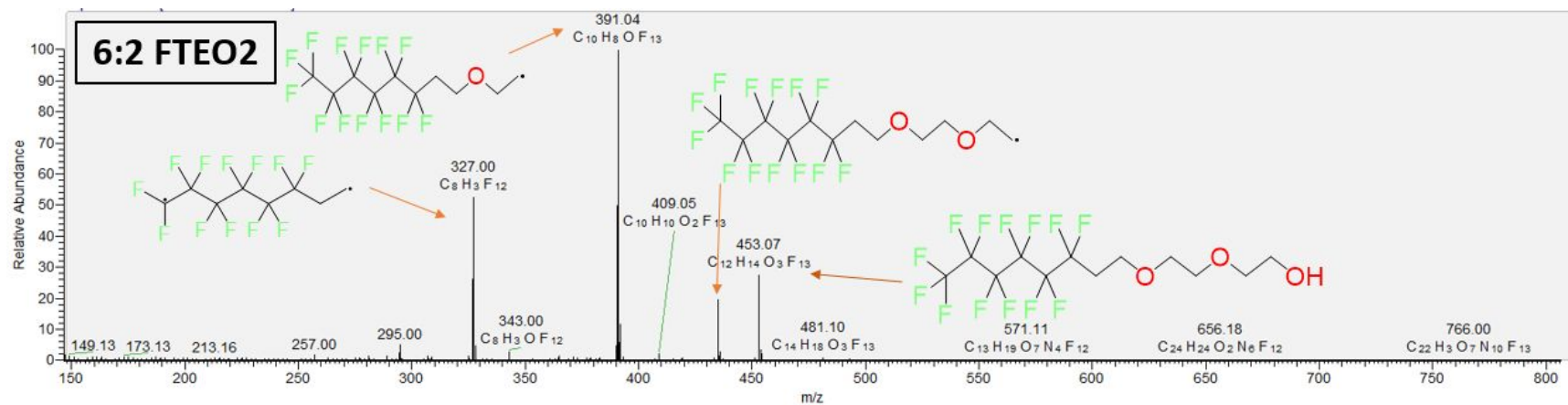


Figure S14: Spectra for 2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)oxy)ethoxy)ethan-1-ol

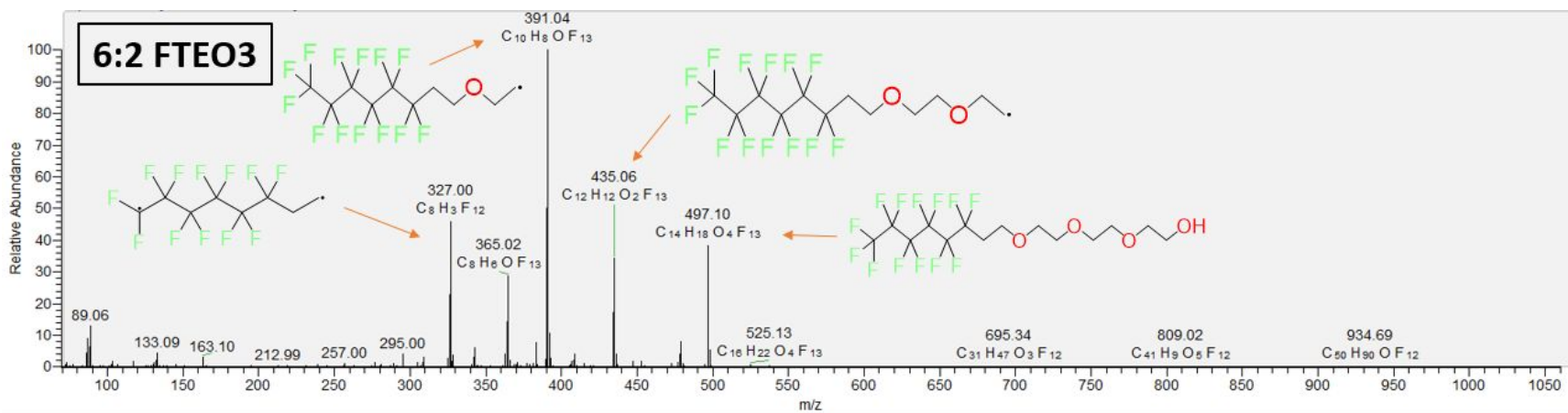


Figure S15: Spectra for 2-(2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)oxy)ethoxy)ethoxy)ethan-1-ol

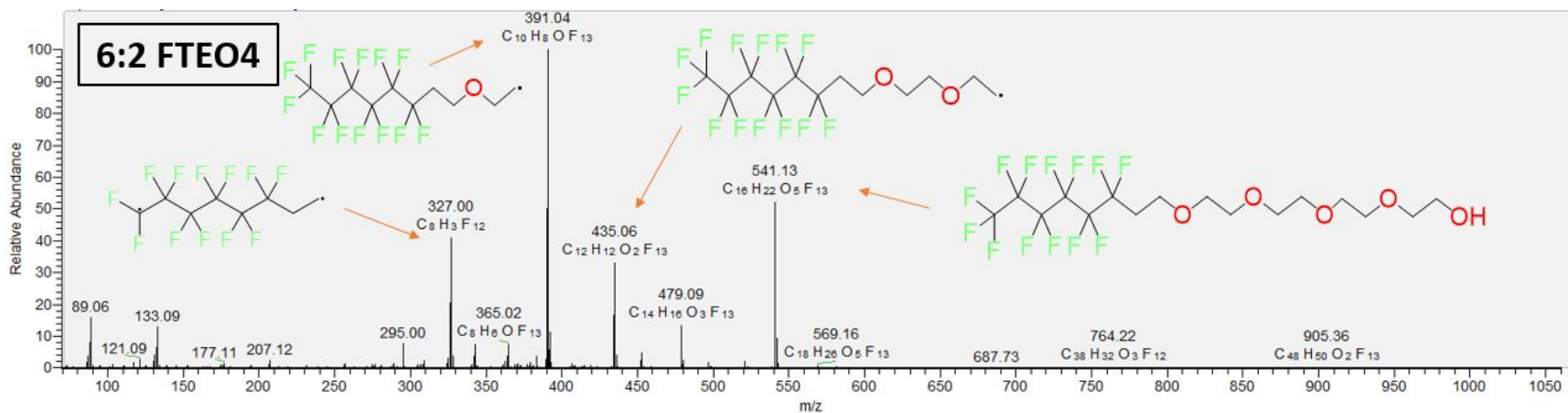


Figure S16: Spectra for 15,15,16,16,17,17,18,18,19,19,20,20,20-tridecafluoro-3,6,9,12-tetraoxaicosan-1-ol

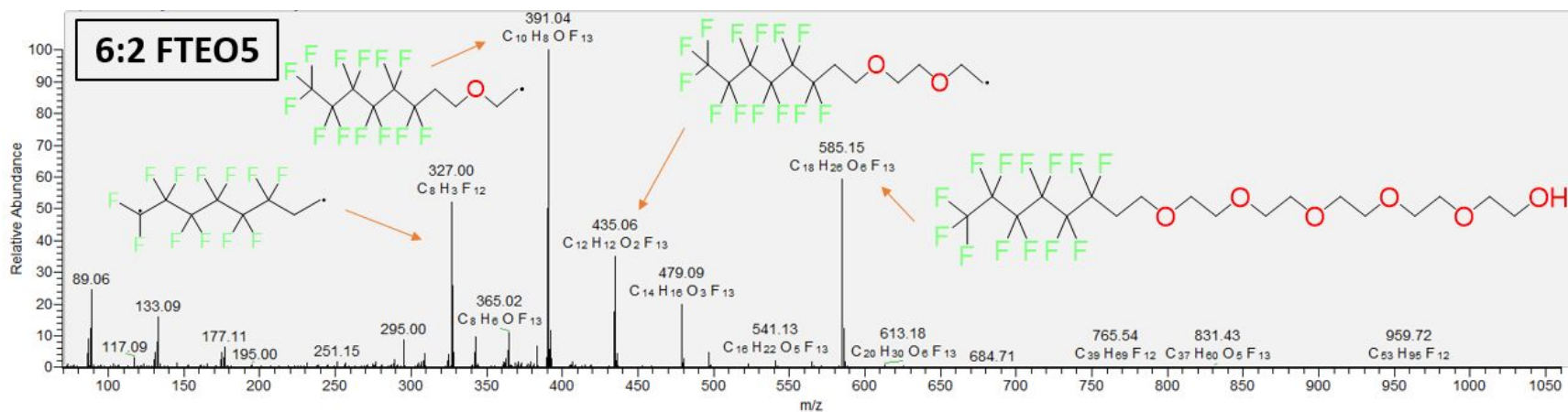


Figure S17: Spectra for 18,18,19,19,20,20,21,21,22,22,23,23-tridecafluoro-3,6,9,12,15-pentaoxatricosan-1-ol

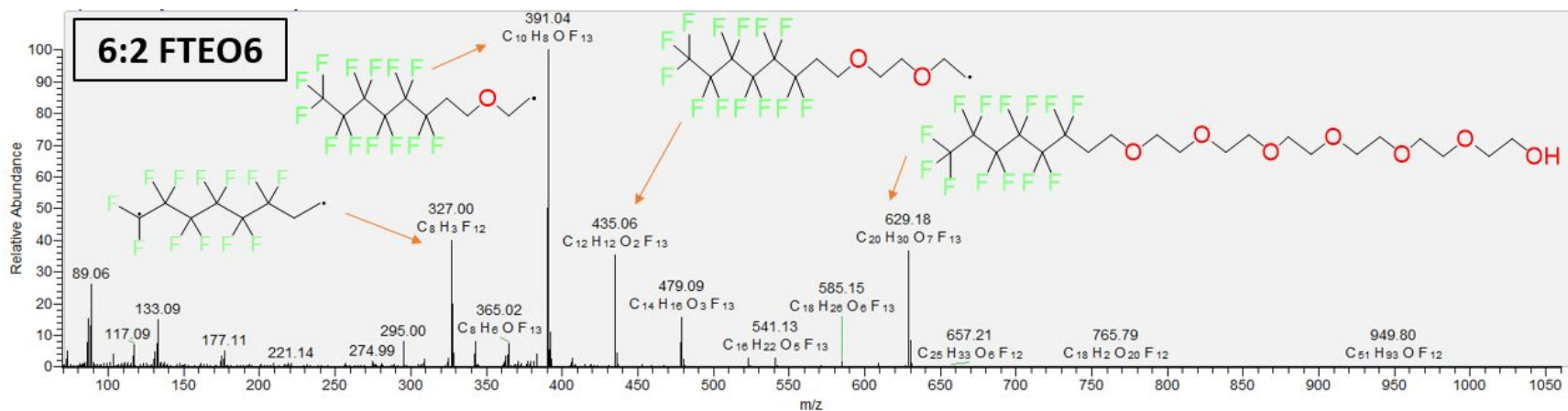


Figure S18: Spectra for 21,21,22,22,23,23,24,24,25,25,26,26,26-tridecafluoro-3,6,9,12,15,18-hexaoxahexacosan-1-ol



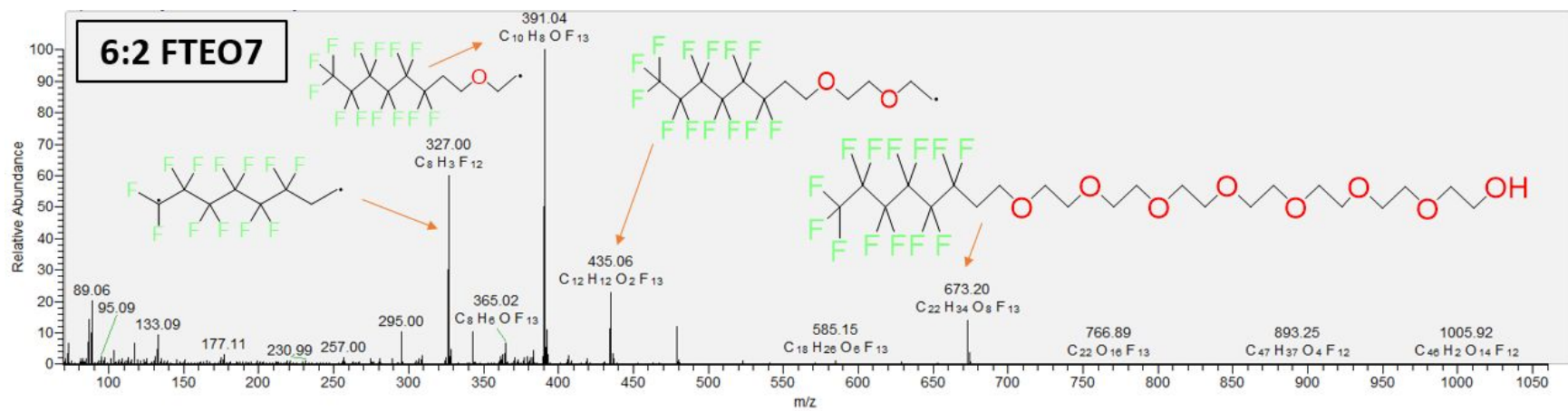


Figure S19: Spectra for 24,24,25,25,26,26,27,27,28,28,29,29,29-tridecafluoro-3,6,9,12,15,18,21-heptaoxanonacosan-1-ol

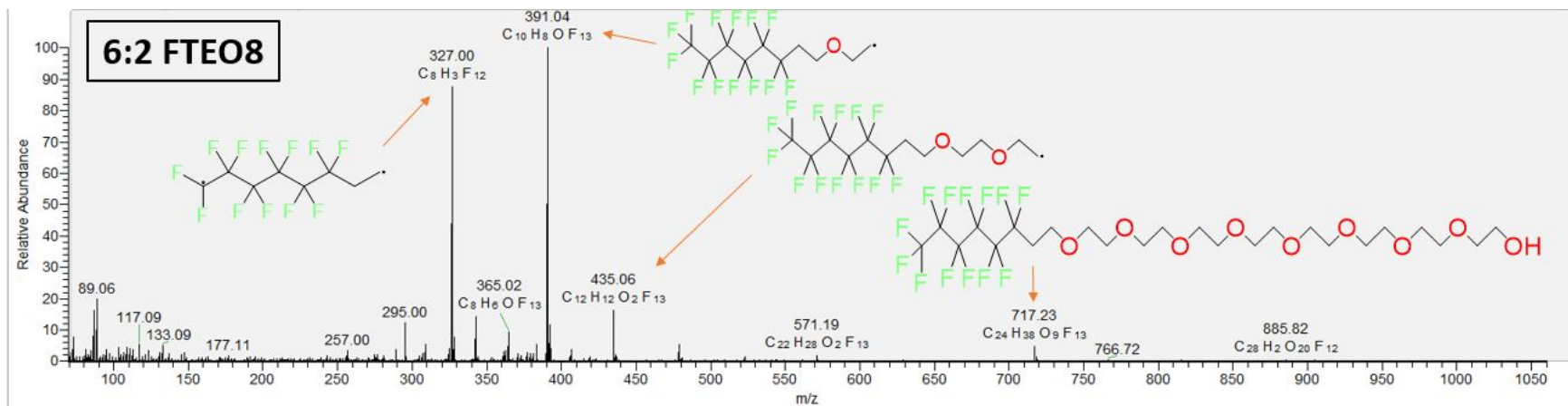


Figure S20: Spectra for 27,27,28,28,29,29,30,30,31,31,32,32,32-tridecafluoro-3,6,9,12,15,18,21,24-octaoxadotriacontan-1-ol

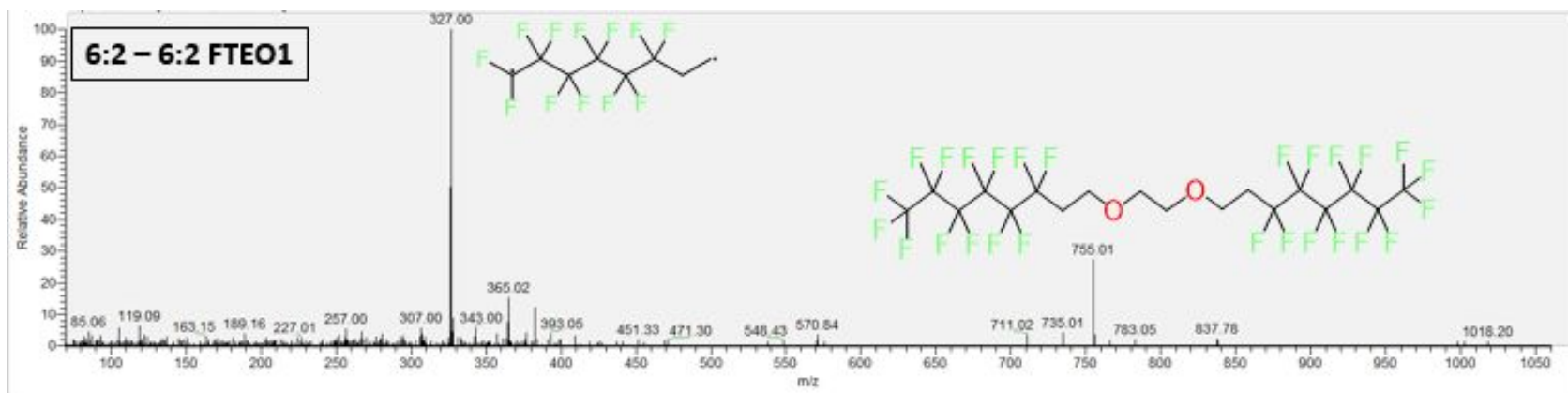


Figure S21: Spectra for 1,2-bis((3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)oxy)ethane

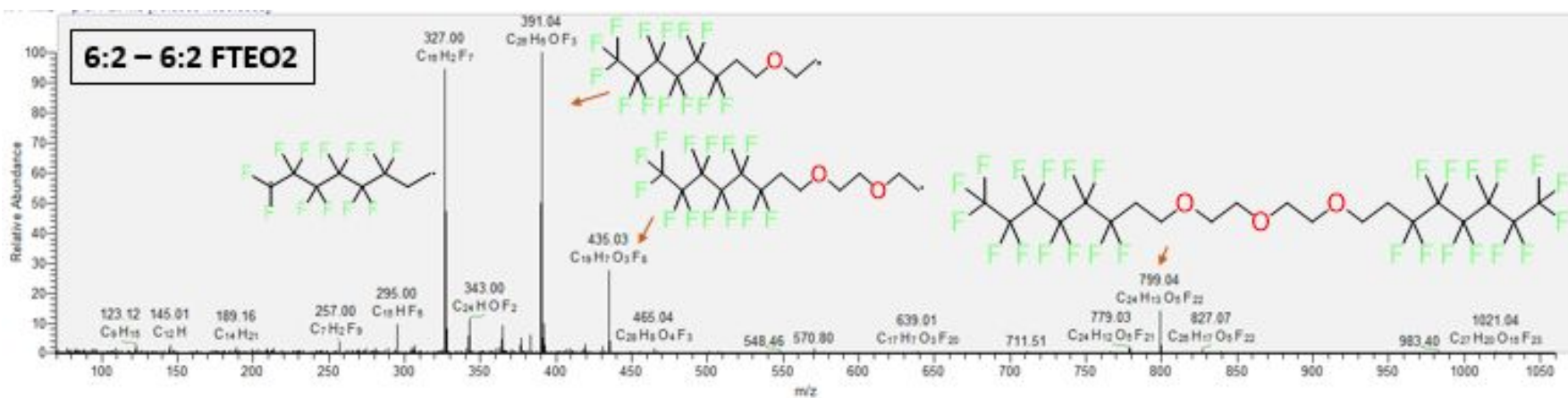


Figure S22: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6-tridecafluoro-8-(2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)oxy)ethoxy)ethoxy)octane

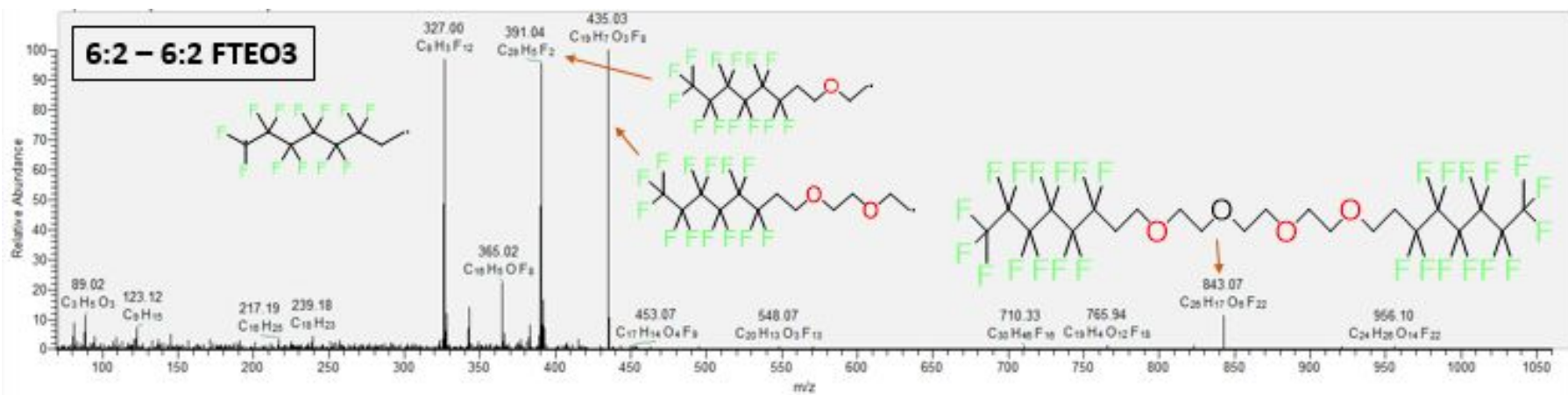


Figure S23: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,21,21,22,22,23,23,24,24,25,25,26,26,26-hexacosafuoro-9,12,15,18-tetraoxahexacosane

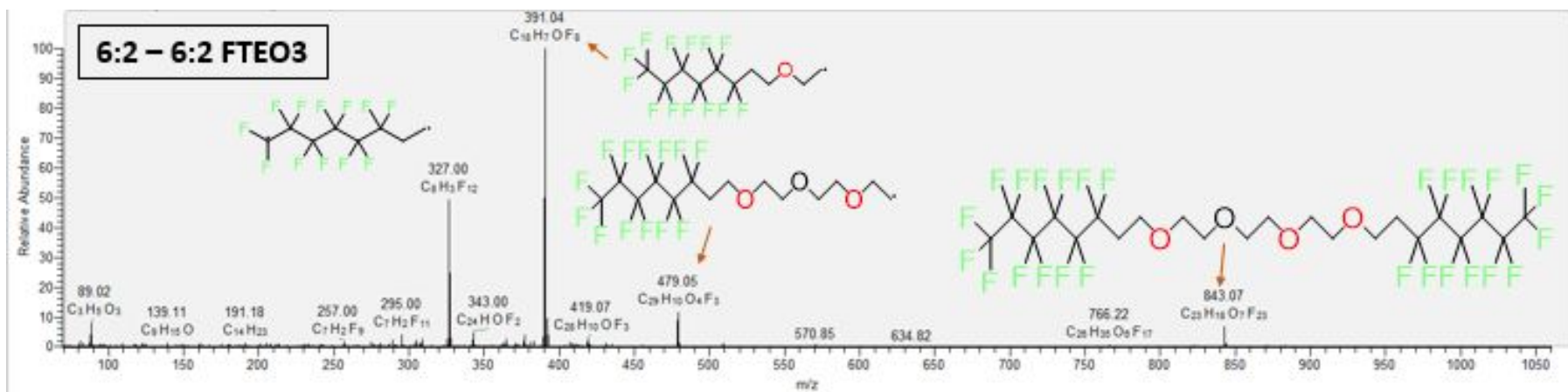


Figure S24: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,21,21,22,22,23,23,24,24,25,25,26,26,26-hexacosafuoro-9,12,15,18-tetraoxahexacosane

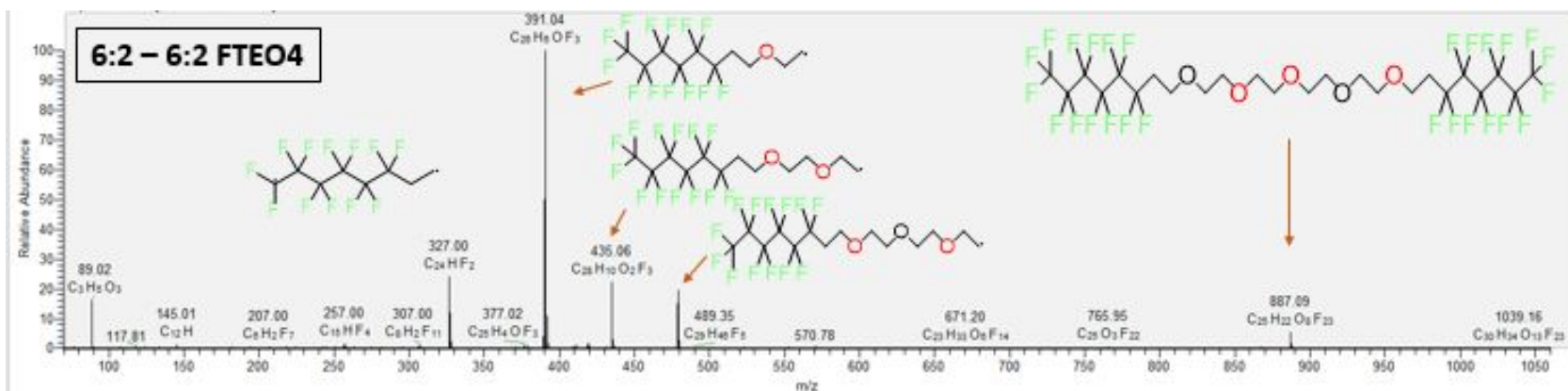


Figure S25: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,24,24,25,25,26,26,27,27,28,28,29,29,29-hexacosafuoro-9,12,15,18,21-pentaoxanonacosane

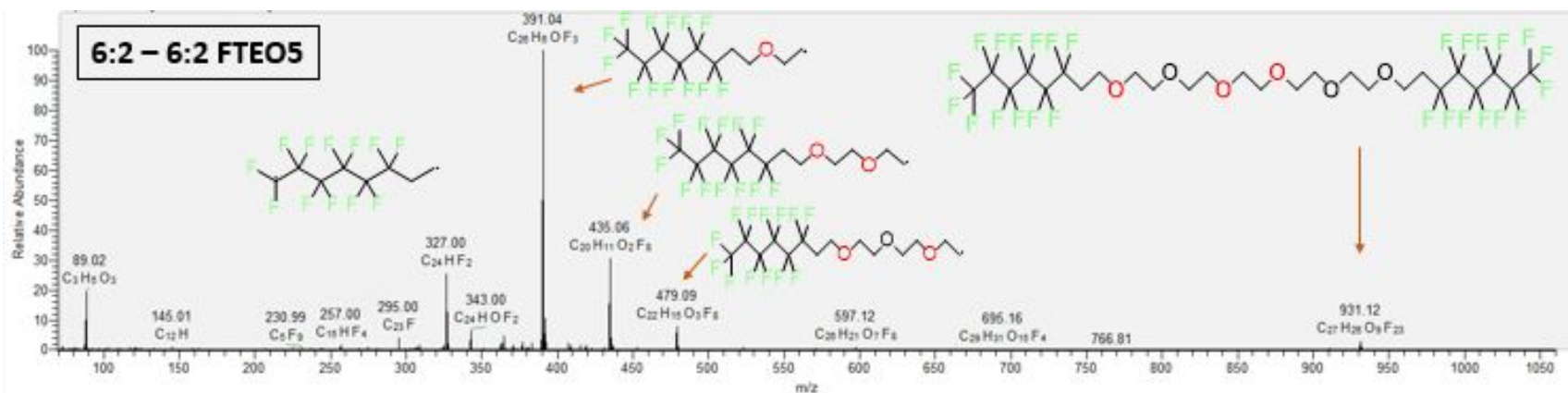


Figure S26: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,27,27,28,28,29,29,30,30,31,31,32,32,32-hexacosafuoro-9,12,15,18,21,24-hexaoxadotriacontane



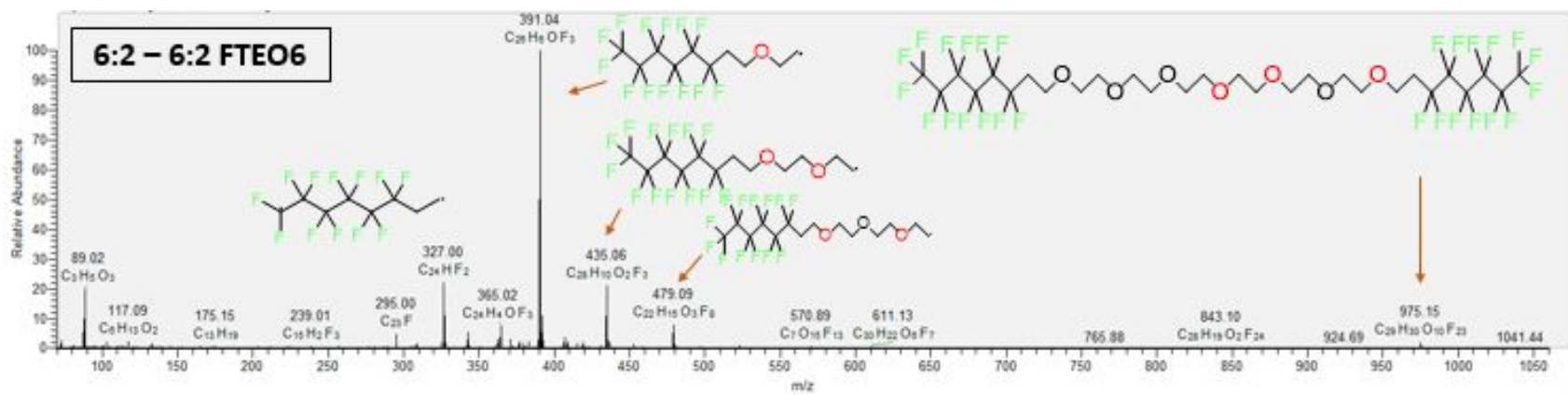


Figure S27: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,30,30,31,31,32,32,33,33,34,34,35,35,35-hexacosafuoro-9,12,15,18,21,24,27-heptaioxapentatriacontane

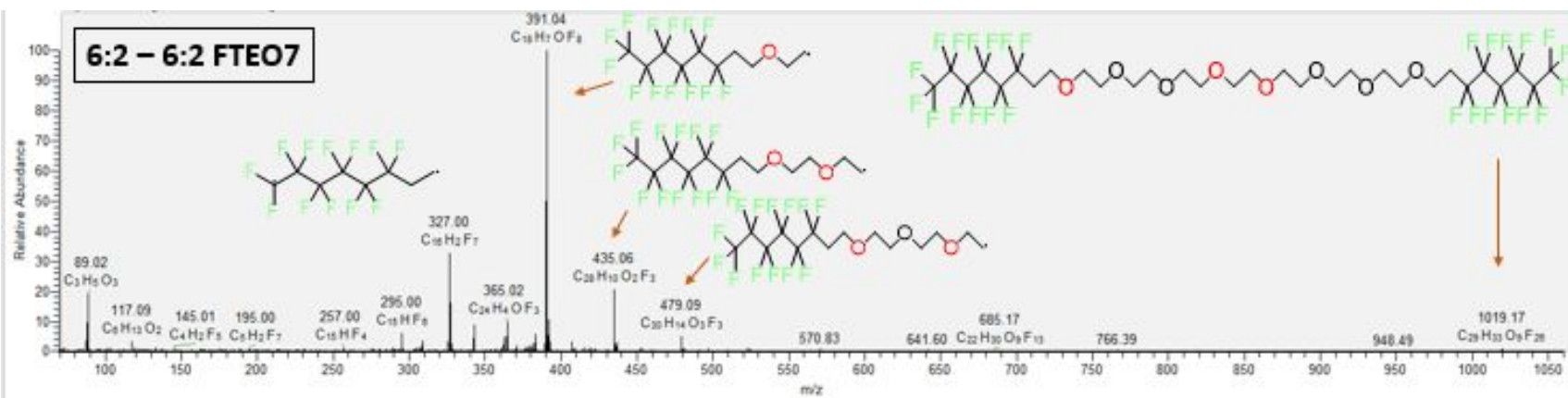


Figure S28: Spectra for 1,1,1,2,2,3,3,4,4,5,5,6,6,33,33,34,34,35,35,36,36,37,37,38,38,38-octaoxaoctatriacontane

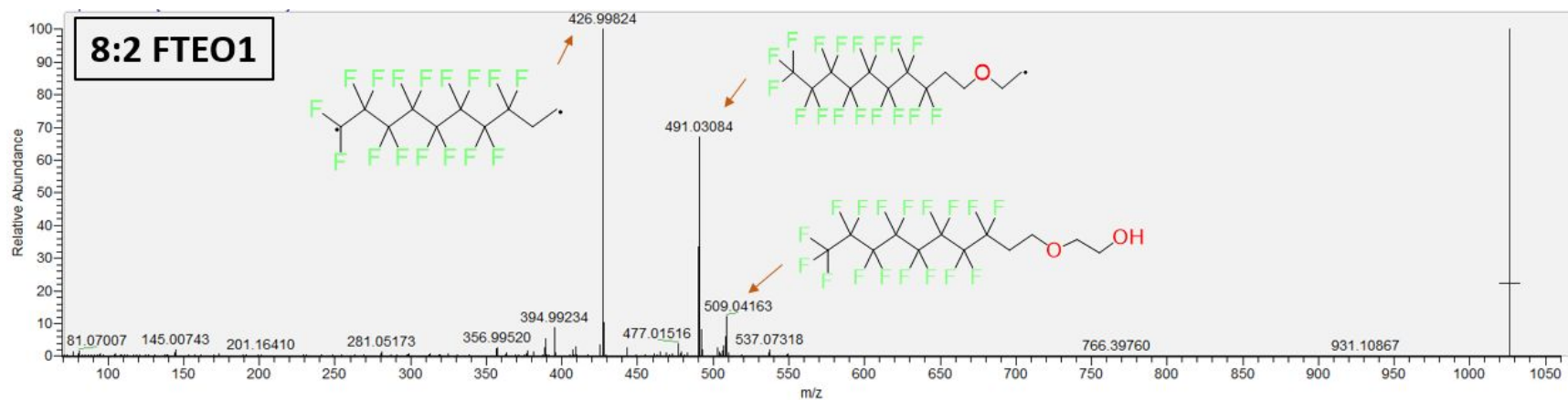


Figure S29: Spectra for 2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)oxy)ethan-1-ol

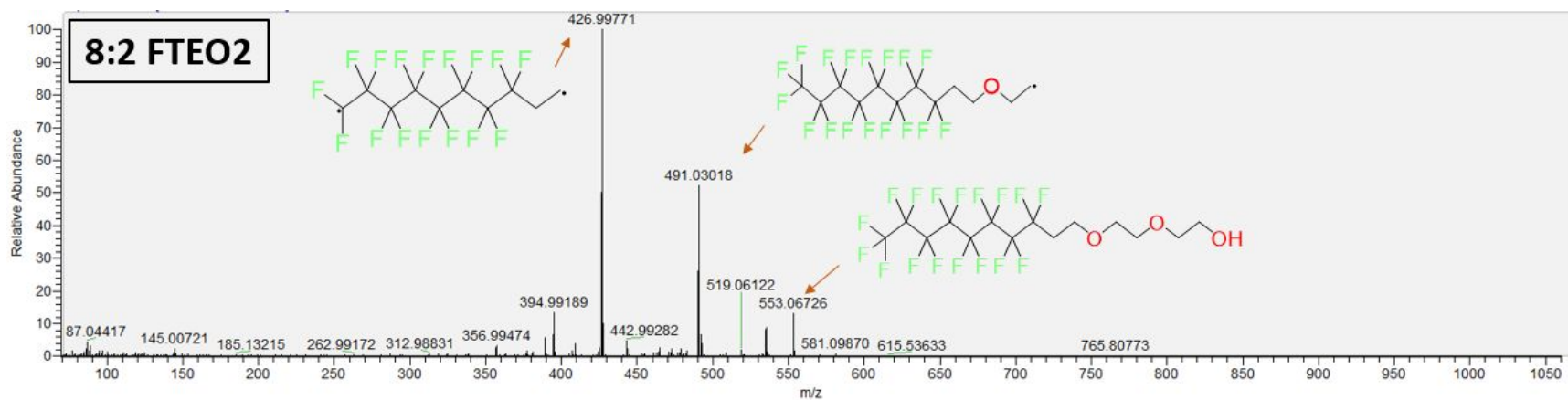


Figure S30: Spectra for 2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)oxy)ethoxy)ethan-1-ol

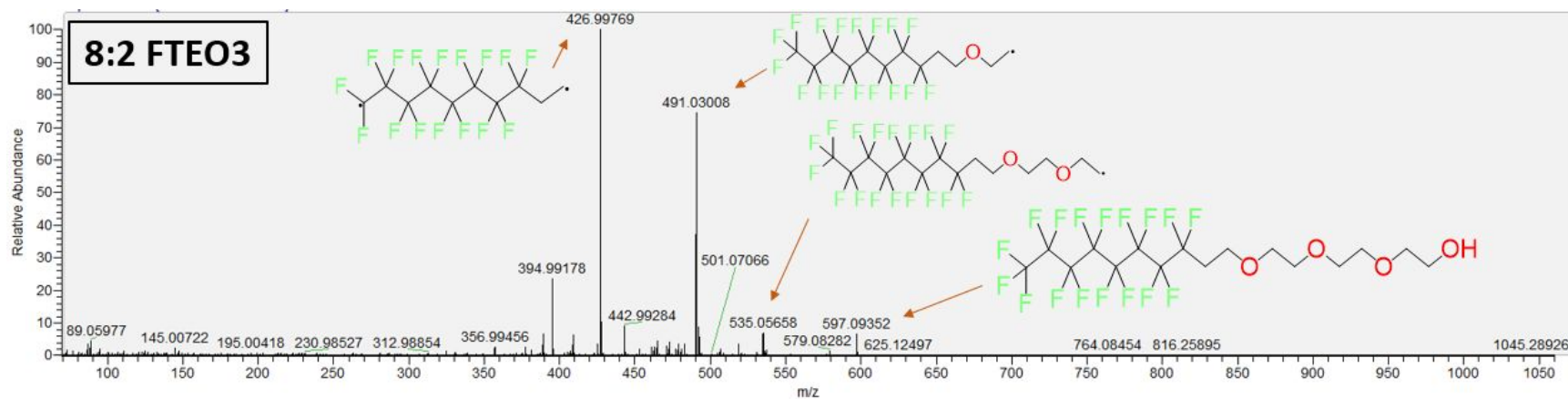


Figure S31: Spectra for 2-(2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptafluorodecyl)oxy)ethoxy)ethoxy)ethan-1-ol

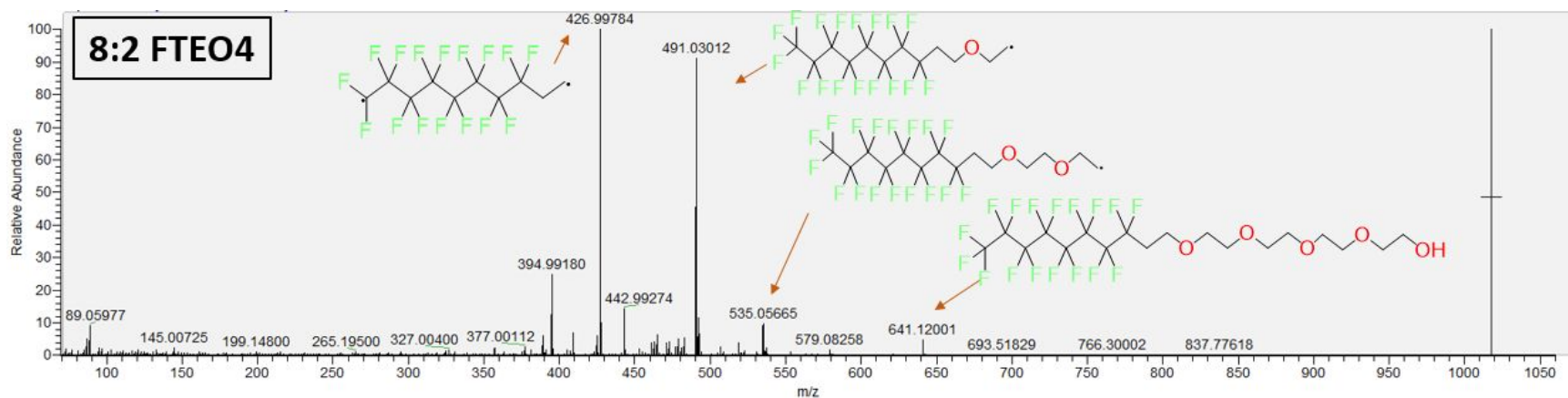


Figure S32: Spectra for 15,15,16,16,17,17,18,18,19,19,20,20,21,21,22,22,22-heptafluoro-3,6,9,12-tetraoxadocosan-1-ol

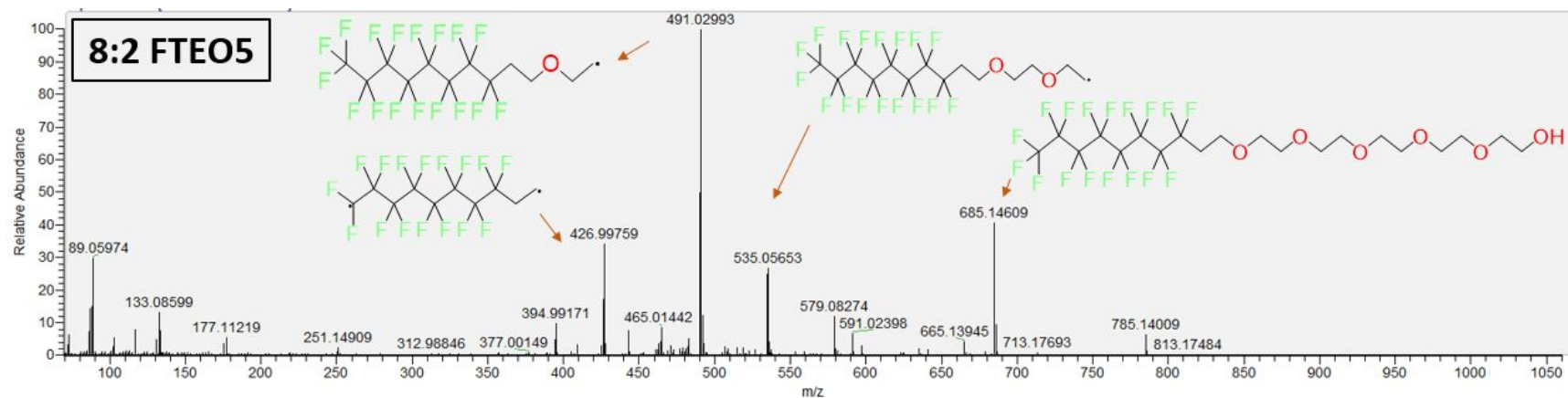


Figure S33: Spectra for 18,18,19,19,20,20,21,21,22,22,23,23,24,24,25,25,25-heptafluoro-3,6,9,12,15-pentaoxapentacosan-1-ol

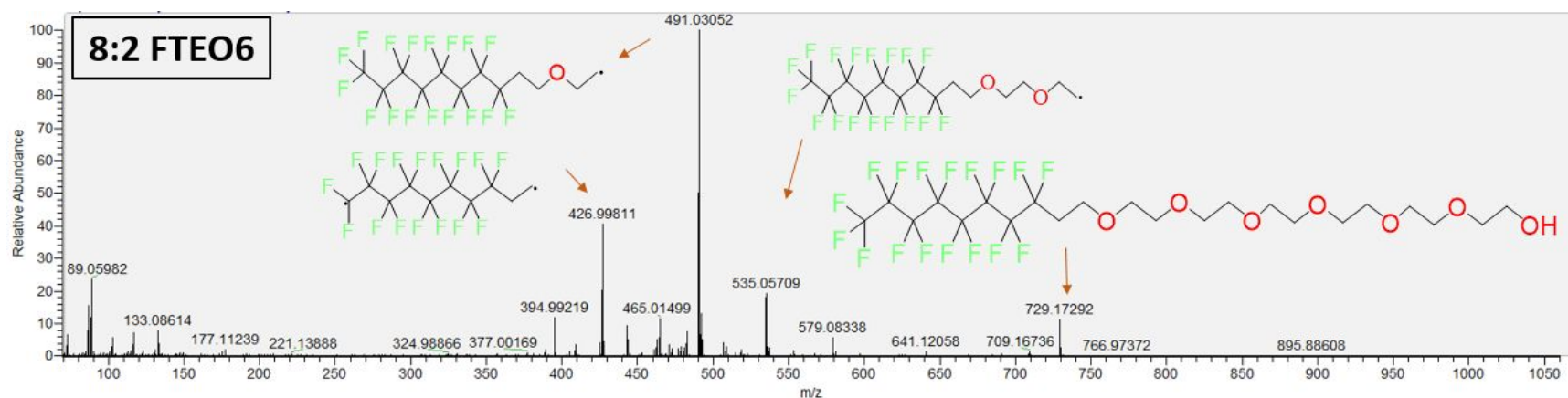


Figure S34: Spectra for 21,21,22,22,23,23,24,24,25,25,26,26,27,27,28,28,28-heptafluoro-3,6,9,12,15,18-hexaoxaoctacosan-1-ol



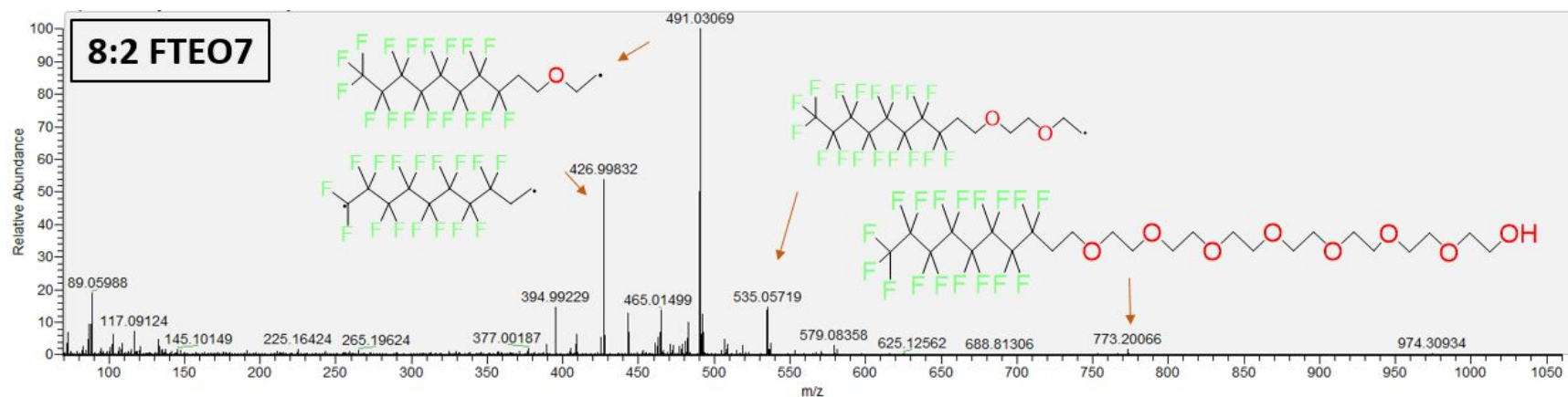


Figure S35: Spectra for 24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,31-heptadecafluoro-3,6,9,12,15,18,21-heptaohentriacontan-1-ol

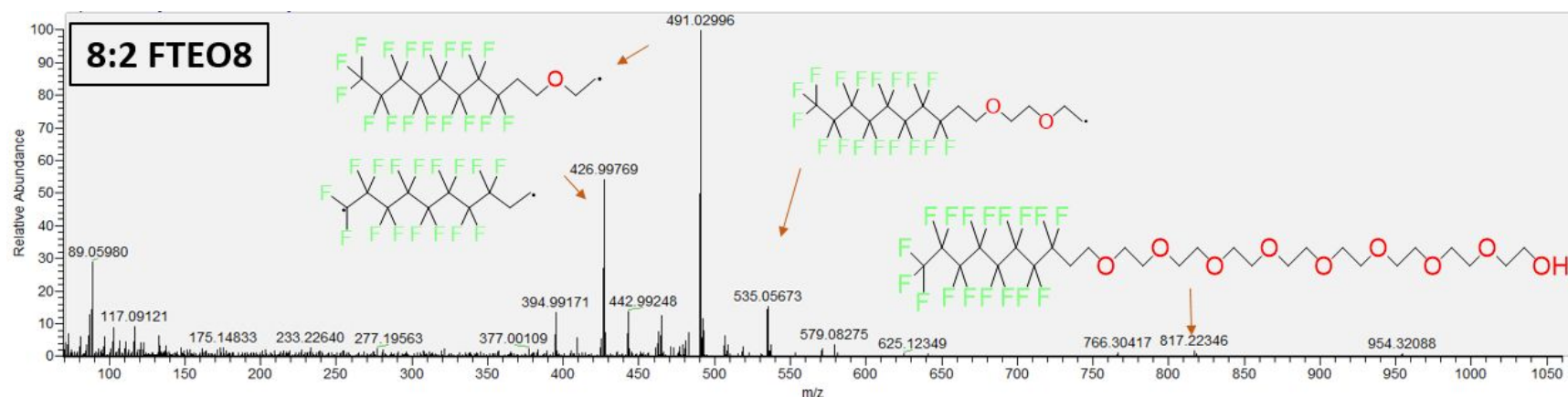


Figure S36: Spectra for 27,27,28,28,29,29,30,30,31,31,32,32,33,33,34,34,34-heptadecafluoro-3,6,9,12,15,18,21,24-octaoxatetriacontan-1-ol

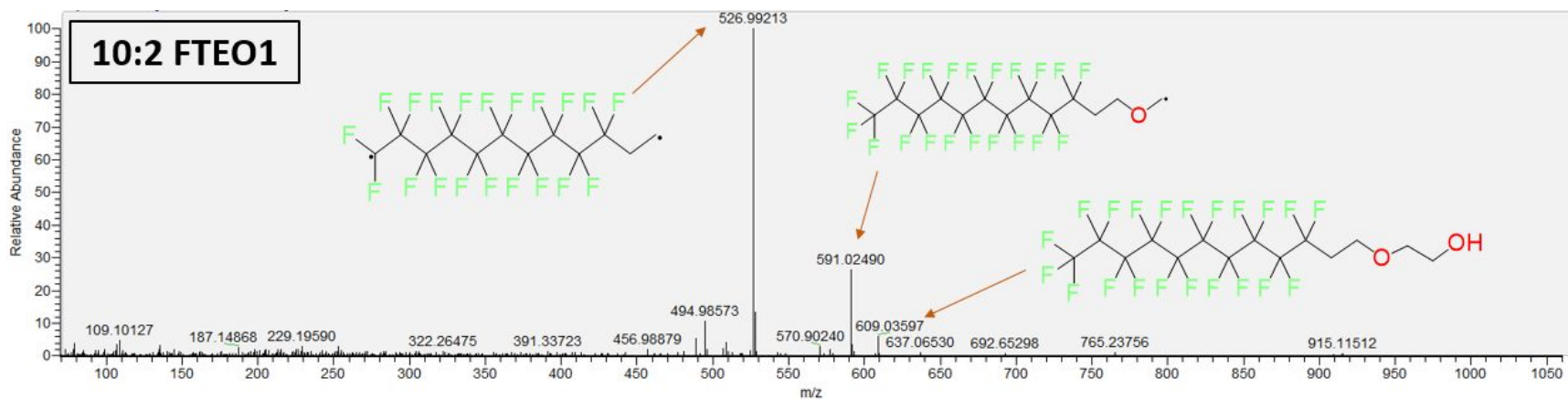


Figure S37: Spectra for 2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-henicosafluorododecyl)oxy)ethan-1-ol

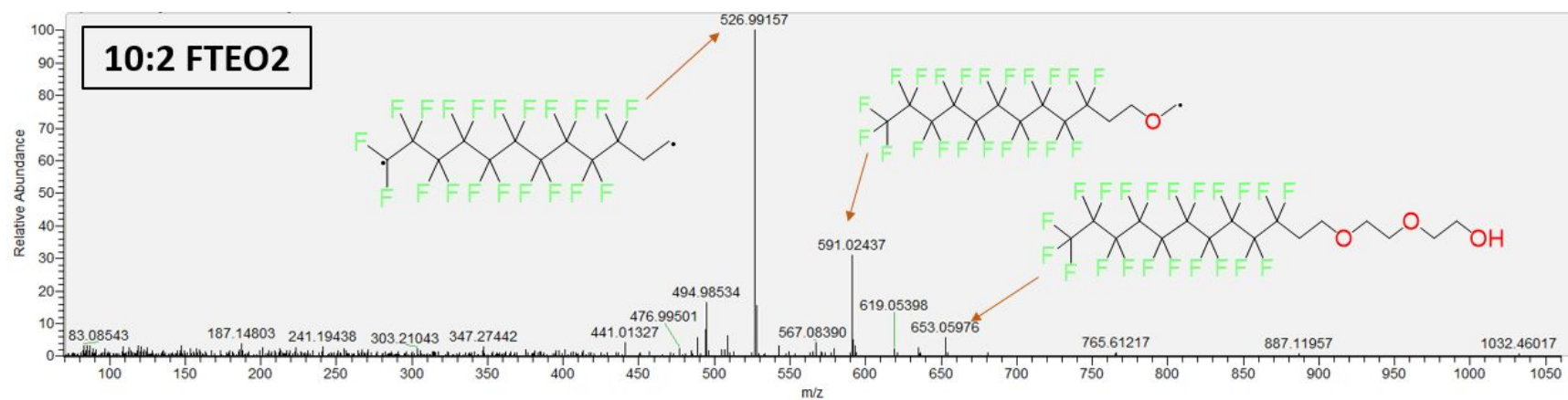


Figure S38: Spectra for 2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-henicosafluorododecyl)oxy)ethoxy)ethan-1-ol

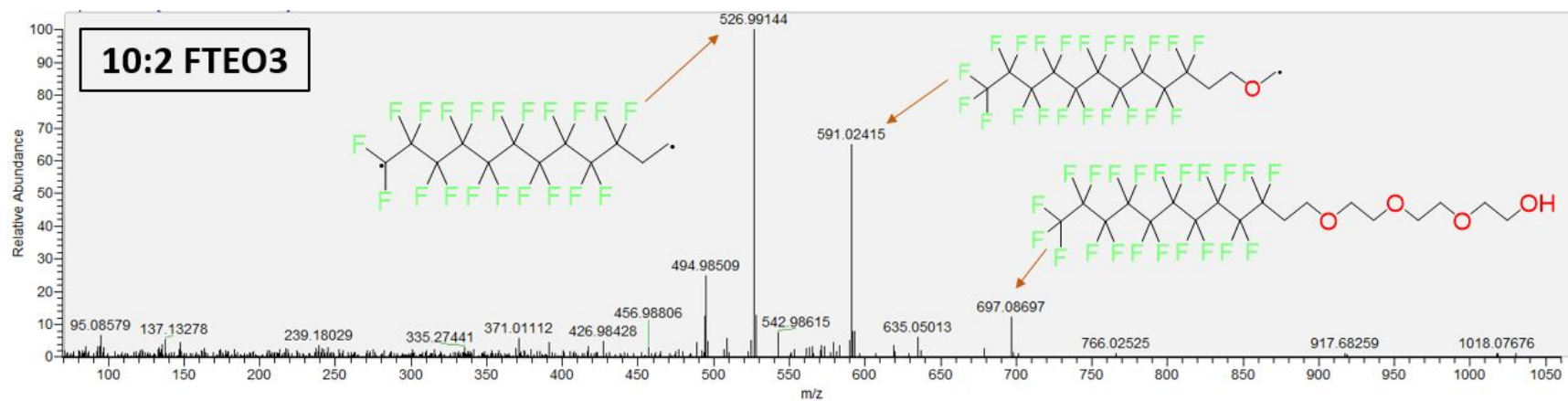


Figure S39: Spectra for 2-(2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12-henicosafuorododecyl)oxy)ethoxy)ethoxy)ethan-1-ol

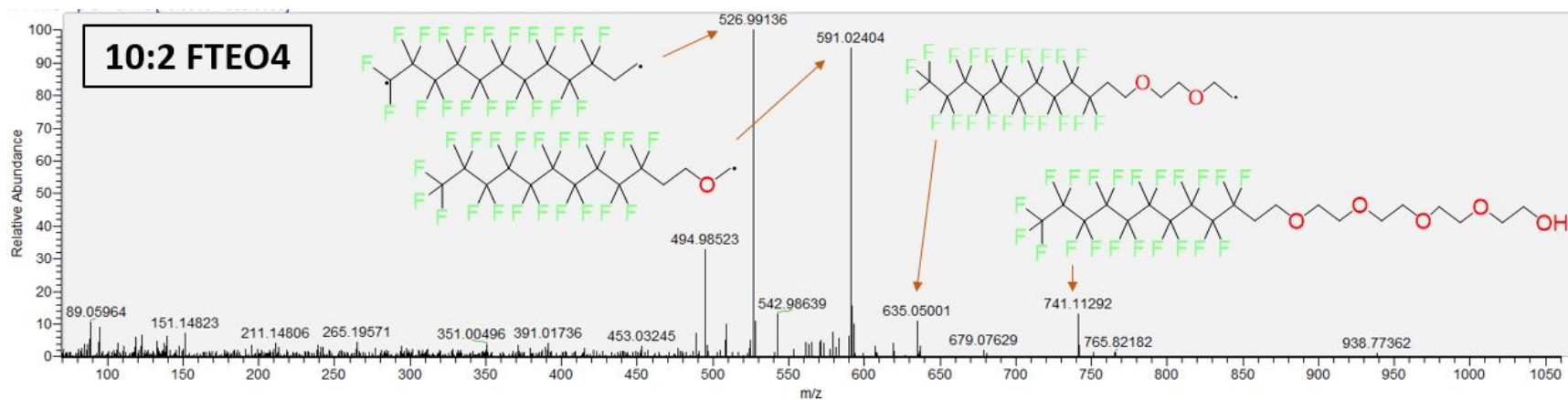


Figure S40: Spectra for 15,15,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,24,24,24-henicosafuoro-3,6,9,12-tetraoxatetracosan-1-ol

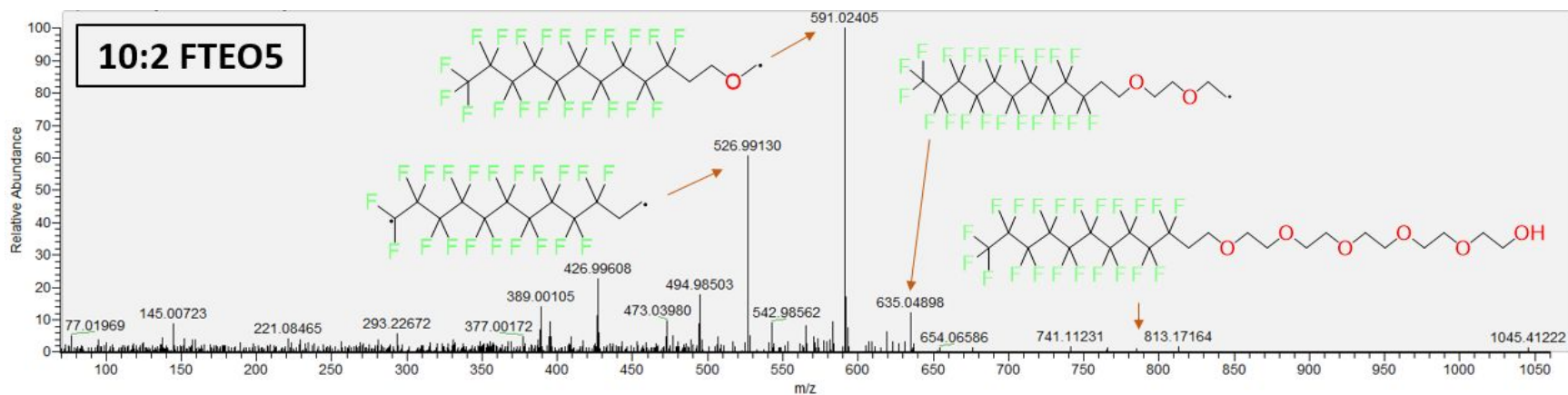


Figure S41: Spectra for 18,18,19,19,20,20,21,21,22,22,23,23,24,24,25,25,26,26,27,27,27-henicosafluoro-3,6,9,12,15-pentaoxaheptacosan-1-ol

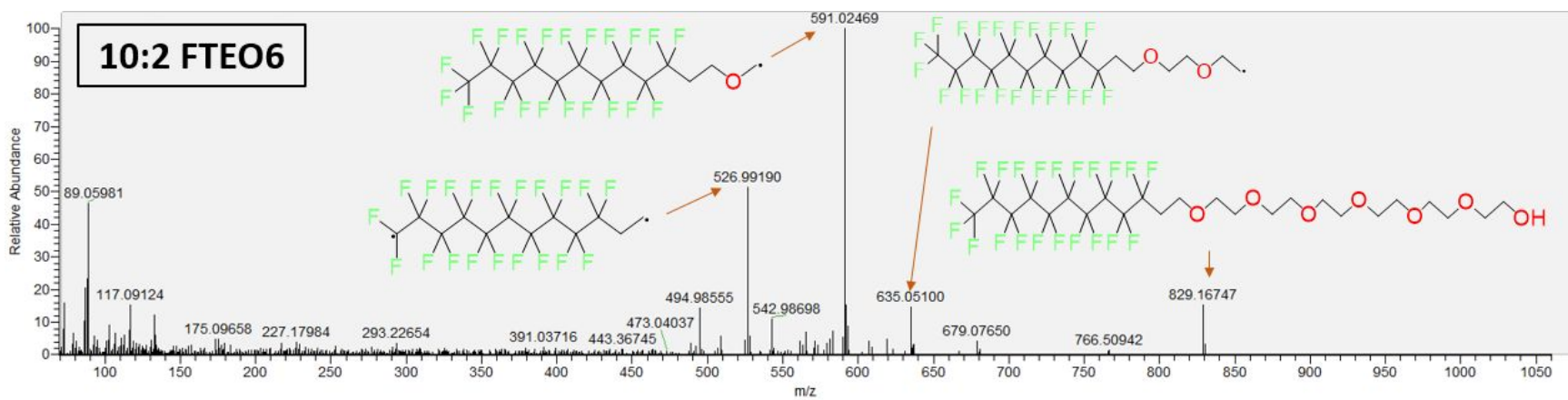


Figure S42: Spectra for 21,21,22,22,23,23,24,24,25,25,26,26,27,27,28,28,29,29,30,30,30-henicosafluoro-3,6,9,12,15,18-hexaoxatriacontan-1-ol



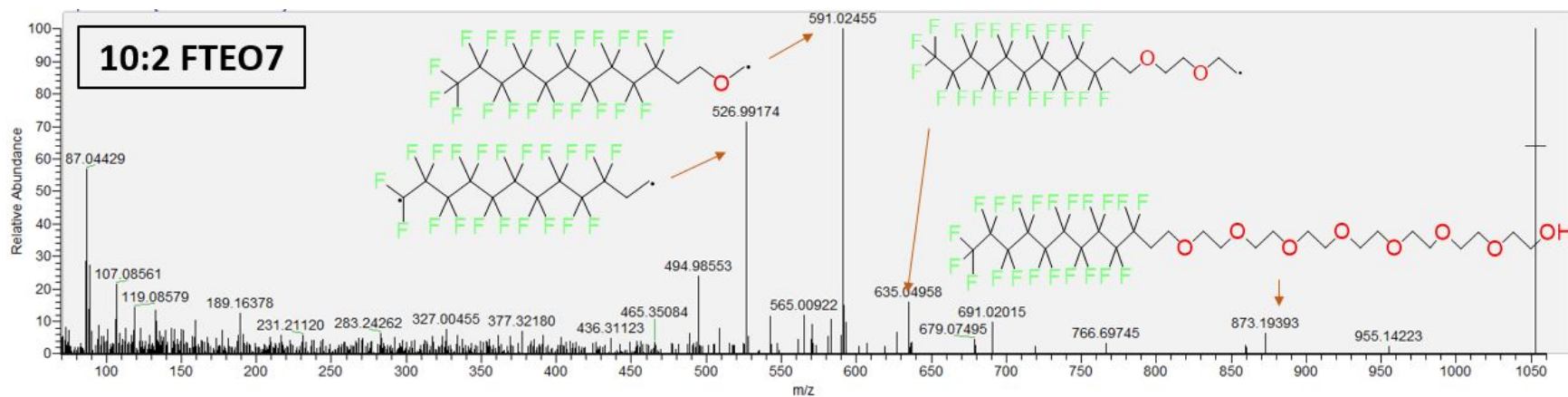


Figure S43: Spectra for 24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,32,32,33,33,33-henicosafluoro-3,6,9,12,15,18,21-heptaoxatriacontan-1-ol

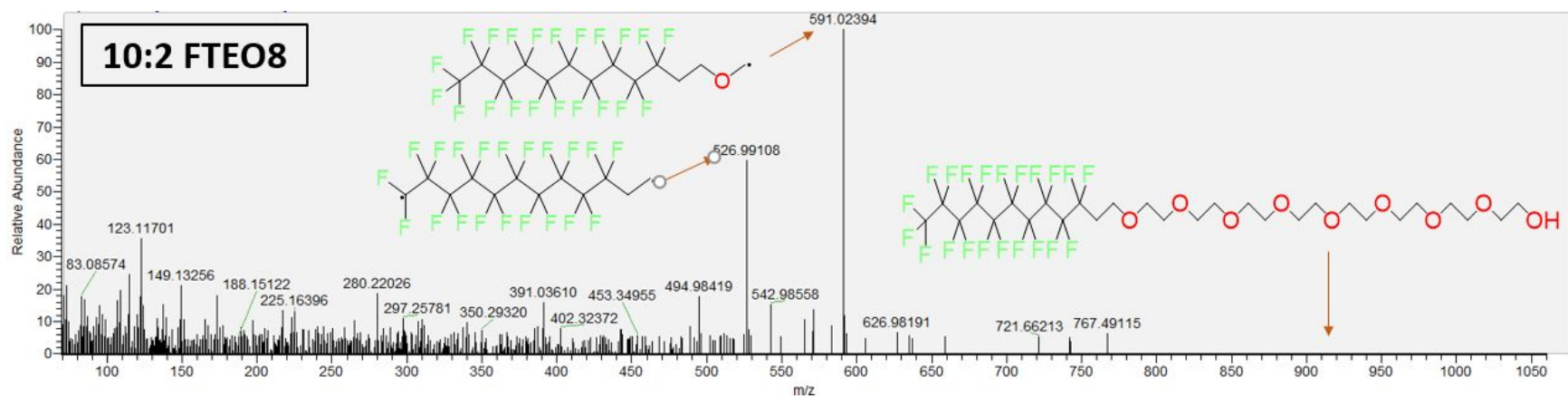


Figure S44: Spectra for 27,27,28,28,29,29,30,30,31,31,32,32,33,33,34,34,35,35,36,36,36-henicosafluoro-3,6,9,12,15,18,21,24-octaoxahexatriacontan-1-ol

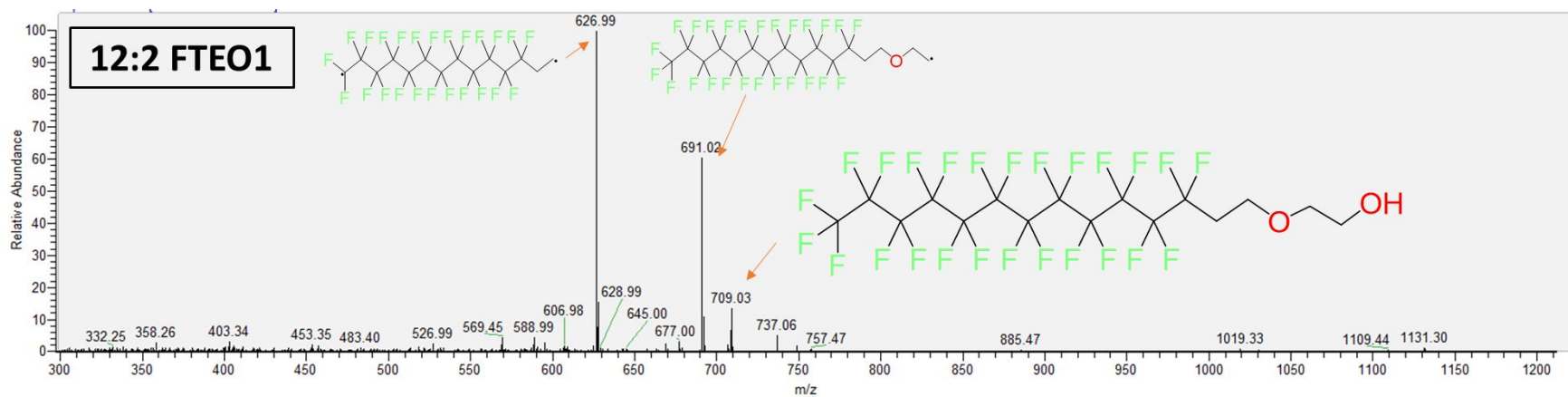


Figure S45: Spectra for 2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,14-pentacosafuorotetradecyl)oxy)ethan-1-ol

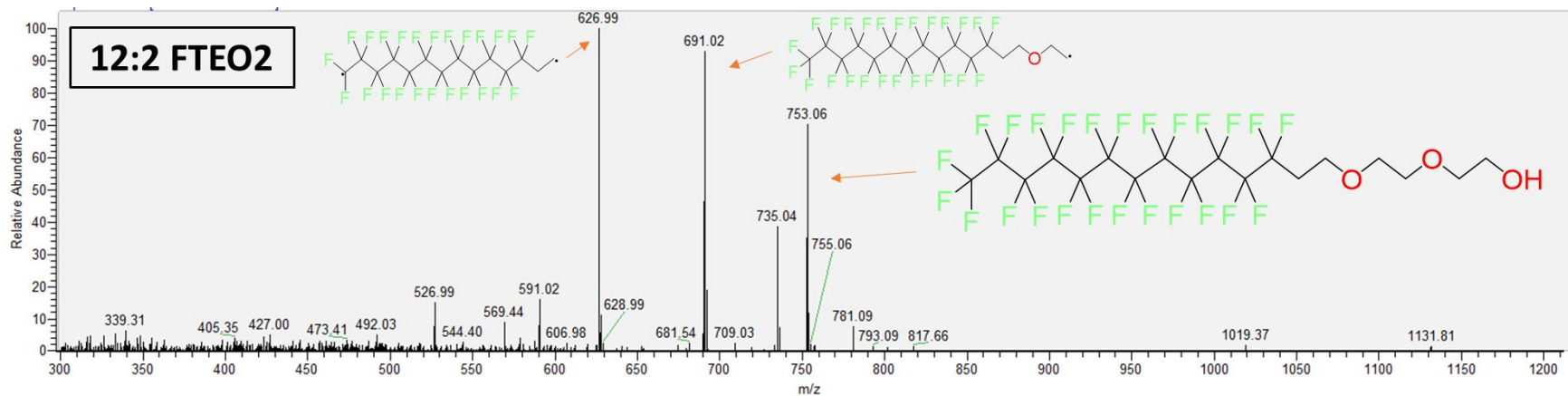


Figure S46: Spectra for 2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,14-pentacosafuorotetradecyl)oxy)ethoxy)ethan-1-ol

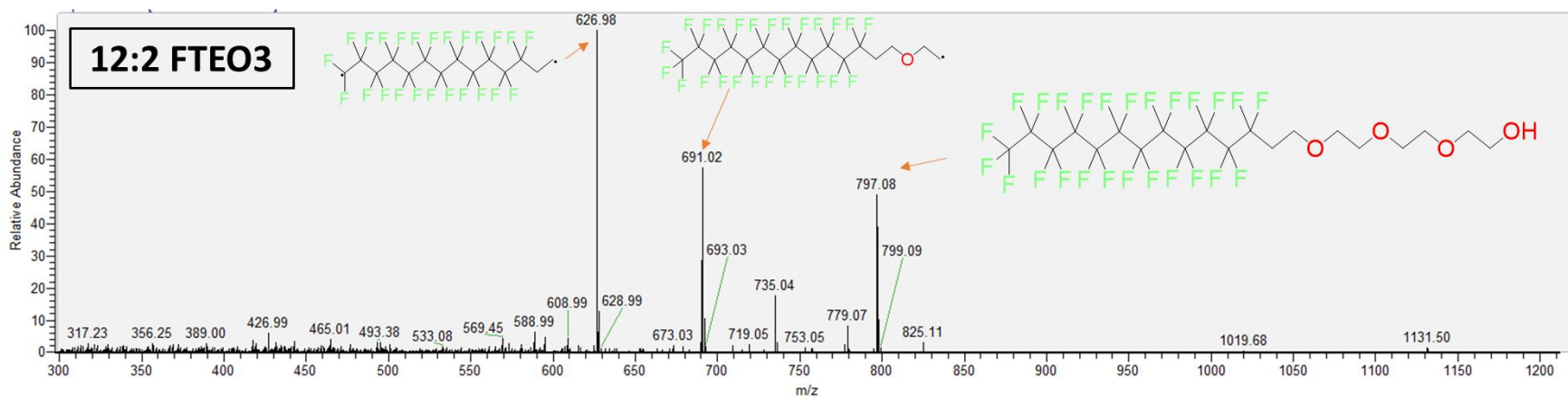


Figure S47: Spectra for 2-(2-(2-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,14-pentacosafuorotetradecyl)oxy)ethoxy)ethoxy)ethan-1-ol

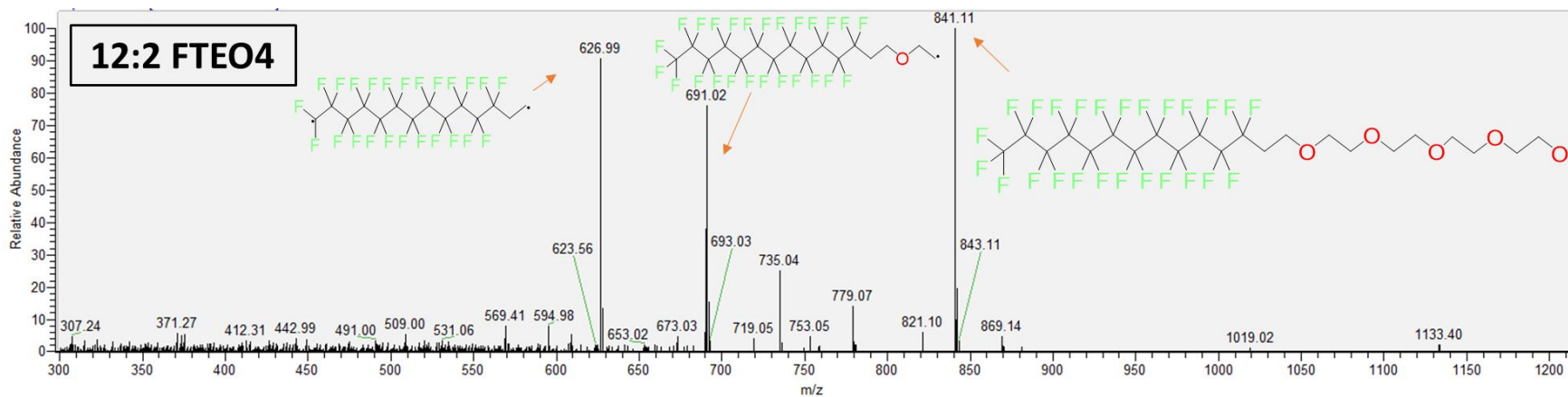


Figure S48: Spectra for 15,15,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,24,24,25,25,26,26,26-pentacosafuoro-3,6,9,12-tetraoxahexacosan-1-ol

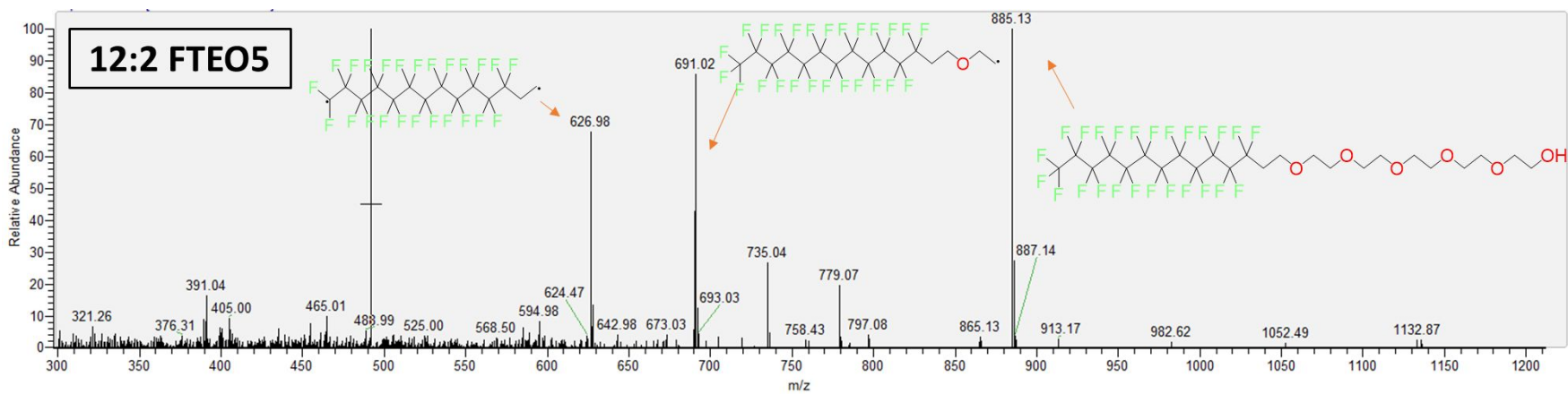


Figure S49: Spectra for 18,18,19,19,20,20,21,21,22,22,23,23,24,24,25,25,26,26,27,27,28,28,29,29,29-pentacosafuoro-3,6,9,12,15-pentaoxanonacosan-1-ol

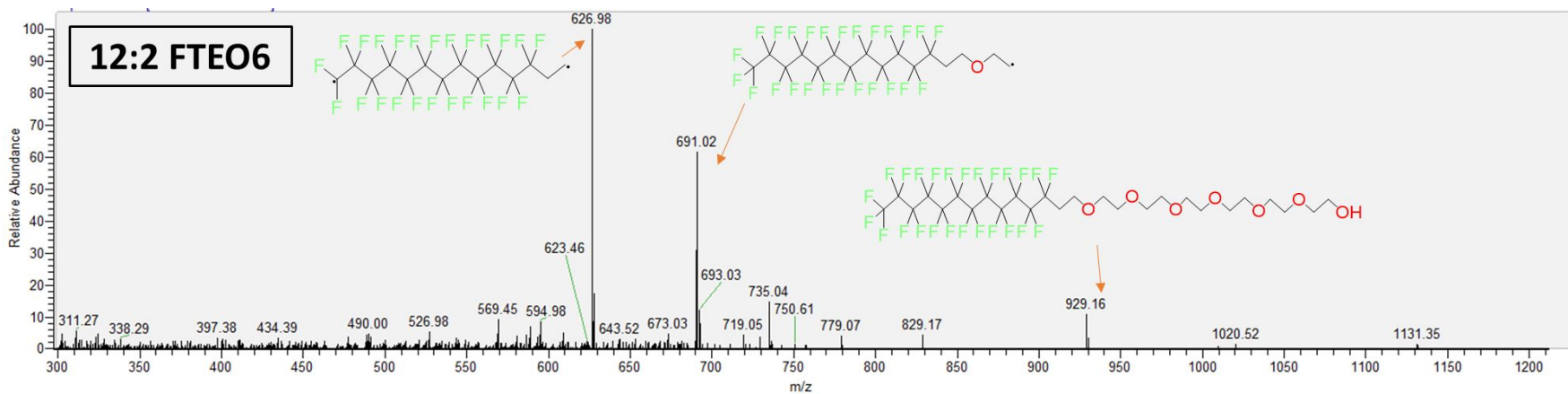


Figure S50: Spectra for 21,21,22,22,23,23,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,32,32,32-pentacosafuoro-3,6,9,12,15,18-hexaoadotriacontan-1-ol

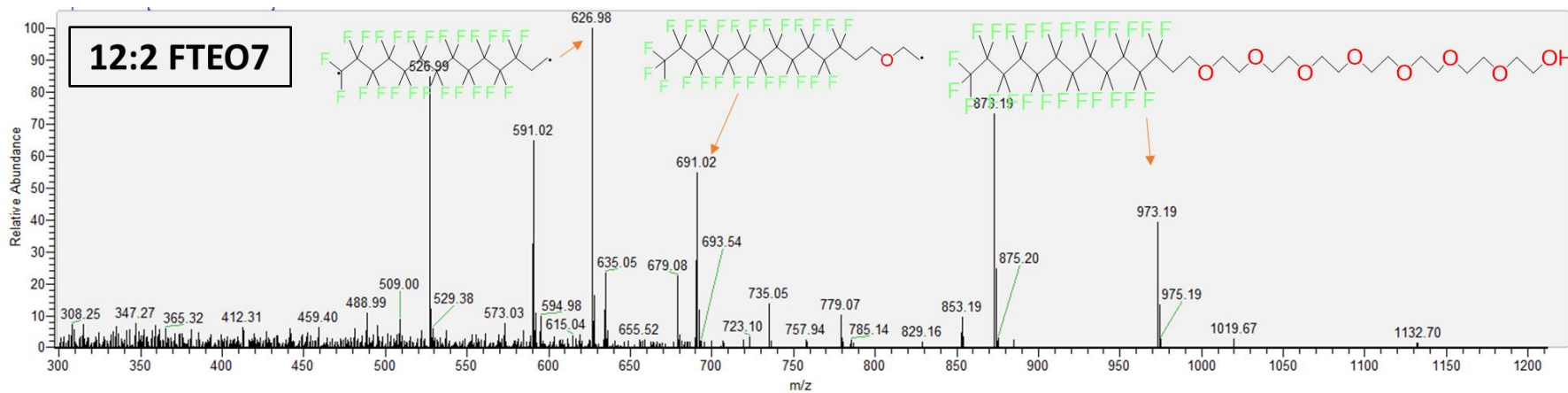


Figure S51: Spectra for 24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,32,32,33,33,34,34,35,35,35-pentacosafuoro-3,6,9,12,15,18,21-heptaioxapentatriacontan-1-ol. **Note:** This spectra includes a coelution with 10:2 FTEO7.

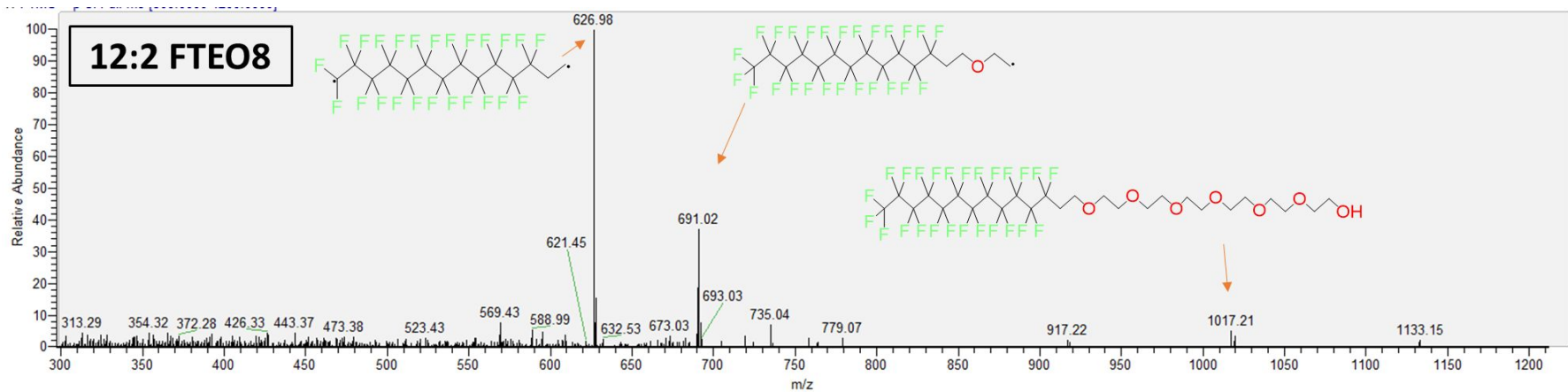


Figure S52: Spectra for 27,27,28,28,29,29,30,30,31,31,32,32,33,33,34,34,35,35,36,36,37,37,38,38,38-pentacosafuoro-3,6,9,12,15,18,21,24-octaoxaoctatriacontan-1-ol