

Supporting Information

Infant Exposure to Emissions of Volatile Organic Compounds from Crib Mattresses

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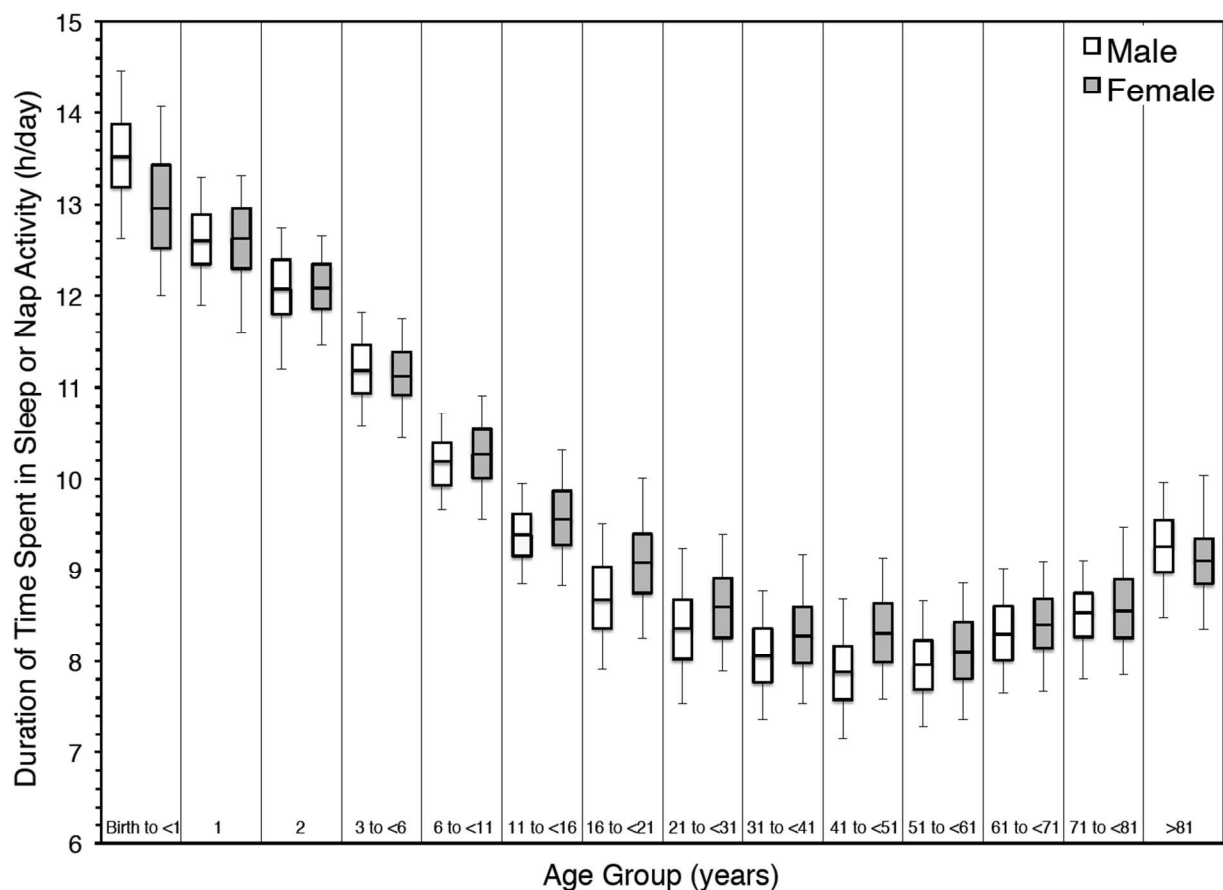


Figure S1. Duration of time (hours/day) spent in sleep or nap activity (EPA ID = 14500), categorized by age group and gender (Adapted from U.S. Environmental Protection Agency (EPA) Exposure Factors Handbook (EFH) data, Sleep or Nap Activity, EPA Activity ID = 14500, U.S. EPA 2009). Box plots represent interquartile range and whiskers represent the 5th and 95th percentiles.

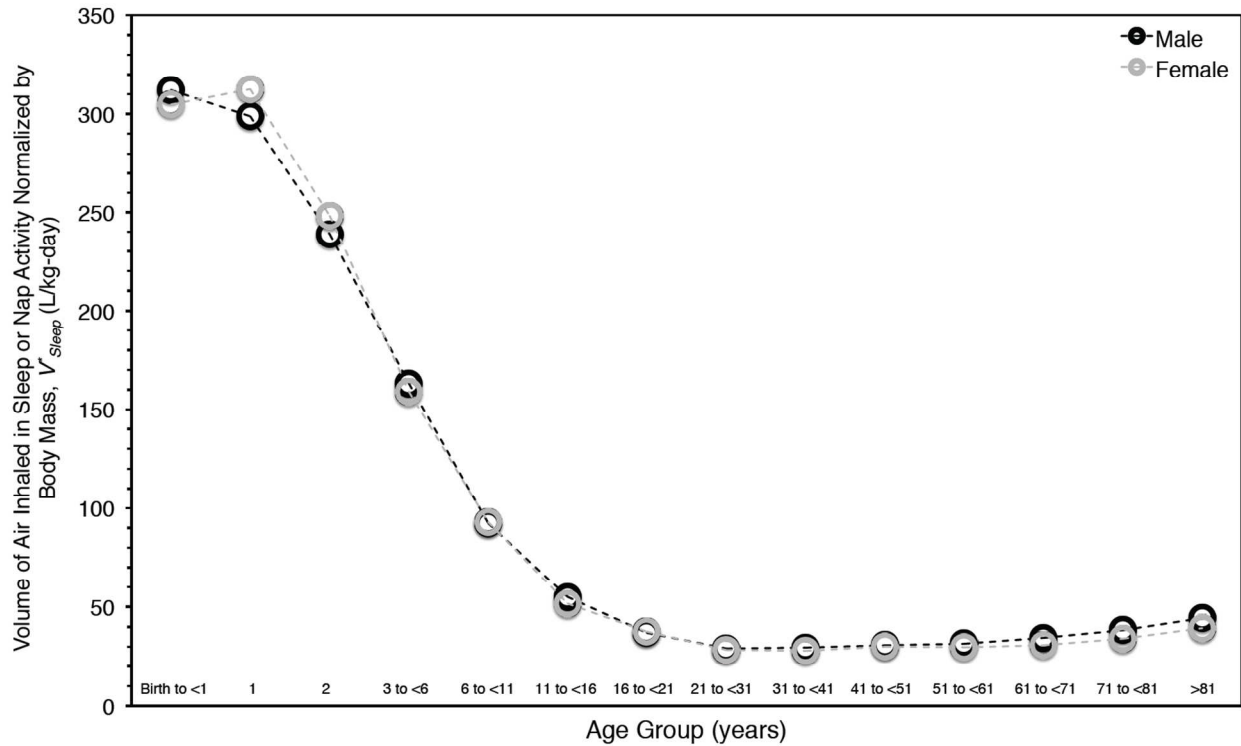


Figure S2. Volume of air inhaled during sleep or nap activity (EPA ID = 14500) per day, normalized by body mass for each age group and gender (calculated using U.S. EPA EFH data set, U.S. EPA 2009).

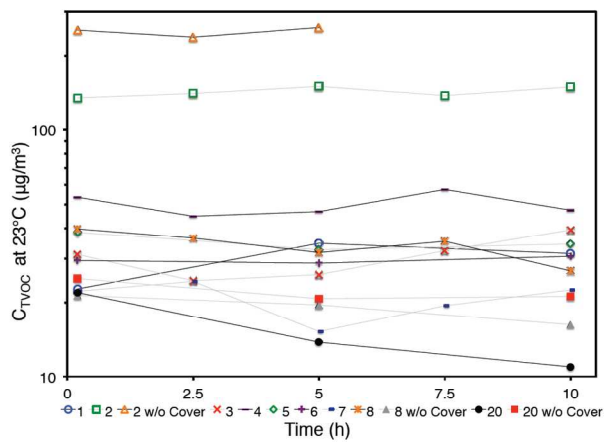


Figure S3 (a.)

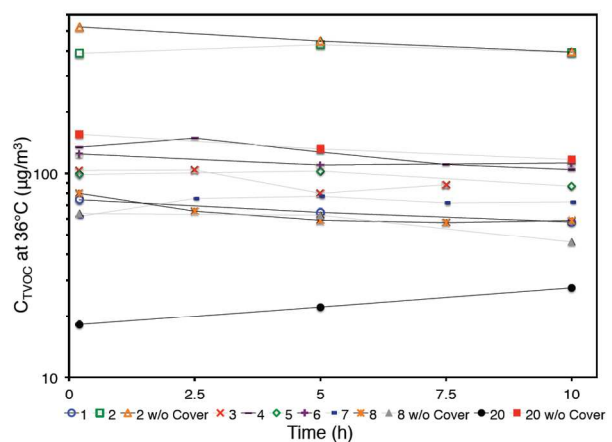


Figure S3 (b.)

Figure S3. Small-scale emissions chamber concentration profiles for new samples (used samples not shown) at 23°C and (b.) at 36°C (plotted on logarithmic axis).

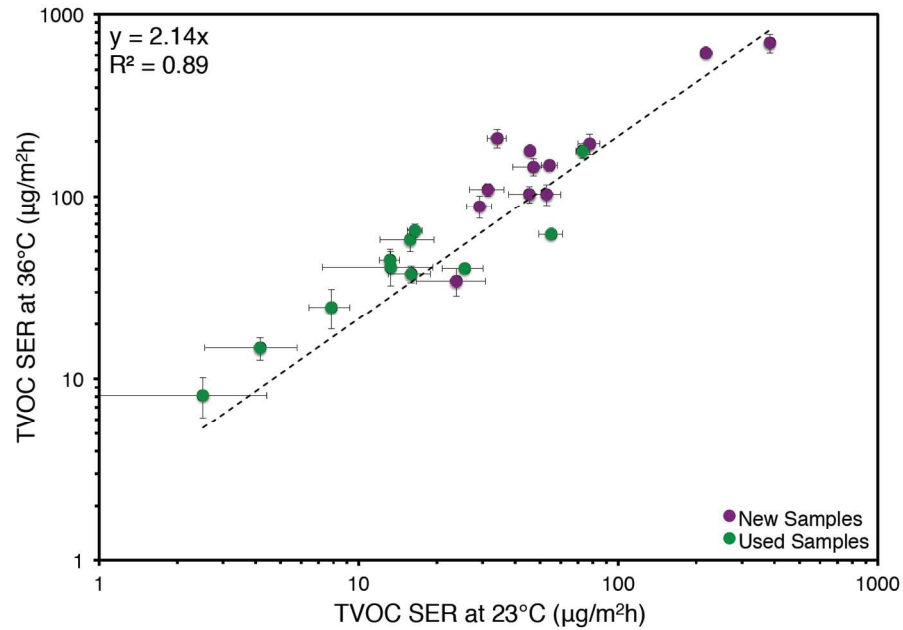


Figure S4. Relationship between TVOC *SER* (both new and used samples) at 23°C and 36°C (plotted on logarithmic axis). Error bars represent the calculated error in the *SER*.

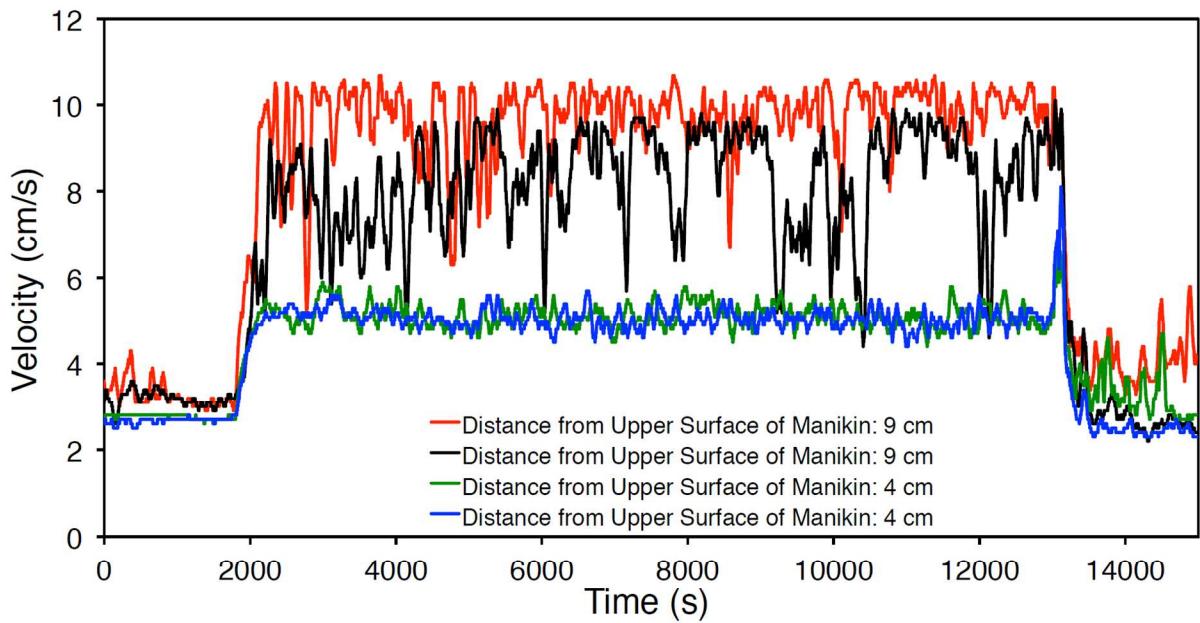


Figure S5. Infant micro-plume: example of air velocity at two heights above heated infant thermal manikin.

Table S1. New and used crib mattress samples

New Samples					Used Samples				
Sample ID	Country of Manufacture	PUF/Poly.	Year Manufactured	Retail Cost	Sample ID	Country of Manufacture	PUF/Poly.	Year Manufactured	Usage
1	USA	Poly.	2011	53USD	9	USA	Poly.	2009	1 yr.
2	USA	PUF	2011	43USD	10	USA	PUF	2005	2 yr.
3	USA	PUF	2011	39USD	11	USA	Poly.	2008	2 yr.
4	USA	Poly.	2011	35USD	12	USA	Poly.	2005	2 yr.
5	USA	Poly.	2011	89USD	13	USA	PUF	2001	2 yr.
6	USA	PUF	2011	70USD	14	USA	PUF	2003	3.5 yr.
7	USA	PUF w/ Soy	2011	120USD	15	USA	PUF	1993	10 yr.
8	USA	PUF w/ Soy	2011	148USD	16	USA	PUF	2007	4 yr.
20	USA	PUF	2011	22USD	17	USA	Poly.	2007	3 yr.
					18	USA	PUF	2003	< 1 yr.
					19	Finland	PUF	2000	Unk.

Table S2. Small-scale and large-scale emission chamber operational and sampling parameters

Volume, V	Chamber Volumetric Flow Rate, Q (m ³ /h)*	Chamber Air Exchange Rate, λ (h ⁻¹)	Exposed Sample Area, A (m ²)	Loading Factor, L (m ² /m ³)	Area Specific Airflow Rate, q (m/h)	Air Sampling Flow Rate, Q_s (mL/min)*	Air Sampling Duration, t_s (min)
<i>Small-Scale Chamber</i>							
0.035 (L)	0.024	695	0.016	457	1.52	100	25
<i>Large-Scale Chamber</i>							
4.5 (m ³)	2.25	0.50	1.49	0.33	1.52	100	50

*Volumetric flow rates were measured with a bubble flow meter (mini-BUCK calibrator, A.P. Buck, Inc.).

Table S3. TVOC *SERs* for new and used infant crib mattresses in small-scale chamber experiments (mean±calculated error)

New Crib Mattress Samples			Used Crib Mattress Samples		
Sample ID	TVOC <i>SER</i> ($\mu\text{g}/\text{m}^2 \text{h}$)		Sample ID	TVOC <i>SER</i> ($\mu\text{g}/\text{m}^2 \text{h}$)	
	23°C	36°C		23°C	36°C
1	45.5±7.8	102.7±10.6	9	73.2±4.4	177.0±14.2
2	218.4±9.5	617.1±27.1	10	15.8±3.7	57.7±8.0
2 w/o Mattress Cover	384.6±14.4	697.2±80.3	11	4.2±1.6	14.7±2.1
3	47.3±8.1	145.2±15.9	12	25.6±4.6	40.4±1.5
4	77.6±7.4	194.4±24.9	13	16.5±1.1	64.9±5.5
5	54.4±3.7	148.7±10.7	14	13.3±6.0	41.0±8.6
6 w/o Mattress Cover	45.7±1.2	178.1±9.9	15	7.8±1.4	24.8±6.1
7	31.5±4.8	109.1±8.2	16	55.2±5.9	62.0±0.3
8	53.1±6.8	102.5±13.4	17	13.2±1.2	44.8±6.4
8 w/o Mattress Cover	29.3±3.3	87.9±12.5	18	2.5±1.9	8.1±2.0
20	23.8±7.1	34.4±5.8	19	15.9±2.9	37.6±4.0
20 w/o Mattress Cover	34.2±2.9	208.2±24.4			

Table S4. Large-scale emissions chamber concentration results (mean±calculated error), sample 6

Case	C_{TVOC} ($\mu\text{g}/\text{m}^3$)			Ratio of Interior Foam to Exhaust	Ratio of BZ to Exhaust
	Interior Foam	BZ	Exhaust		
Manikin Heating On With Mattress Cover	168.4±13.7	14.2±2.3	8.0±0.4	21.0	1.8
Manikin Heating Off Without Mattress Cover	137.9±15.6	31.2±7.1	18.4±5.8	7.5	1.7
Manikin Heating On Without Mattress Cover	157.0±8.9	33.2±2.9	14.1±0.7	11.2	2.4

Table S5. VOC *SERs* for new and used infant crib mattresses in small-scale chamber experiments (mean±calculated error)

Compound ¹	MSD Retention Time (min)	CAS	MW ² (g/mol)	BP ² (°C)	Sample ID	New/Used	PUF/Poly.	VOC <i>SER</i> at 23°C (µg/m ² h)	VOC <i>SER</i> at 36°C (µg/m ² h)
Phenol	17.65	108-95-2	94.1112	182	2	New	PUF	34.2±1.8	151±5.4
					2 w/o Cover	New	PUF	62.2±3.1	257±18.6
					3	New	PUF	1.0±0.5	4.6±0.8
					4	New	Poly.	1.7±0.7	3.4±2.6
					6 w/o Cover	New	PUF	1.3±0.3	6.7±0.8
					7	New	PUF	2.9±0.7	20.2±1.8
					20	New	PUF	< 1	11±2.8
					20 w/o Cover	New	PUF	10.0±0.7	74.9±5.7
					9	Used	Poly.	4.9±0.7	8.5±1.0
					19	Used	PUF	< 1	7.1±0.1
Isooctanol	17.93	26952-21-6	130.2279	180	1	New	Poly.	6.3±0.4	6.6±2.2
					2 w/o Cover	New	PUF	< 1	4.9±2.2
					19	Used	PUF	2.8±1.1	4.3±0.8
Neodecanoic acid	26	26896-20-8	172.2646	262	1	New	Poly.	3.4±0.1	9.2±0.4
					4	New	Poly.	21.9±0.9	33.4±2.9
					5	New	Poly.	18.4±0.5	39.8±1.7
					9	Used	Poly.	4.0±0.2	9.9±0.7
Hexanoic acid, 2-ethyl-	21.97	149-57-5	144.2114	227	2	New	PUF	54.8±2.7	213.4±11.2
					2 w/o Cover	New	PUF	45.5±7.1	118.9±54.6
					6 w/o Cover	New	PUF	< 1	6.3±0.4
					7	New	PUF	2.2±0.5	8.2±1.0
					8	New	PUF	6.3±0.8	32.5±1.1
					20	New	PUF	1.9±0.4	12.0±1.2
					20 w/o Cover	New	PUF	14.2±0.8	72.6±4.9
					9	Used	Poly.	3.8±0.4	7.1±0.5
					13	Used	PUF	1.2±0.1	4.9±0.3
					1-Heptanol, 3-methyl-	19.22	1070-32-2	130.2279	186
2 w/o Cover	New	PUF	21.1±10.9	7.3±2.1					
5	New	Poly.	8.4±0.5	22±2.8					
8	New	PUF	8.0±2.0	8.1±3.1					
D-Limonene	19.31	5989-27-5	136.2340	177	3	New	PUF	10.6±0.9	18±2.8

					7	New	PUF	3.6±0.2	9.2±0.8
Propanenitrile, 2,2'-azobis[2-methyl-	17.91	78-67-1	164.2077	236	6 w/o Cover	New	PUF	10.9±1.9	18.1±2.9
2-Propanol, 1,3-dichloro-	14.26	96-23-1	128.985	175	7	New	PUF	2.3±0.3	11.6±2.0
(S)-3-Ethyl-4-methylpentanol	19.36	--	130.2279	--	1	New	Poly.	6.1±0.8	8.7±1.3
					20	New	PUF	1.5±0.6	2.8±0.6
					19	Used	PUF	1.5±0.1	3.1±0.8
Linalyl acetate	25.59	115-95-7	196.2860	220	3	New	PUF	6.7±0.5	21±3.3
					7	New	PUF	2.4±0.1	6.7±0.5
Cyclopropane, pentyl-	19.28	2511-91-3	112.2126	128	1	New	Poly.	6.4±4.4	21.8±2.5
Linalool	21.23	78-70-6	154.2493	199	3	New	PUF	2.8±0.7	10.1±1.4
					2 w/o Cover	New	PUF	40.6±1.0	33.5±3.9
Benzenemethanol, α,α -dimethyl-	20.65	617-94-7	136.1910	202	6 w/o Cover	New	PUF	1.3±0.1	4±0.2
1-Hexanol, 2-ethyl-	19.1	104-76-7	130.2279	183	6 w/o Cover	New	PUF	2.5±0.4	7.7±1.7
					12	Used	Poly.	2.8±0.8	7.4±0.2
					16	Used	PUF	6.4±0.8	8.3±0.5
2,6-Bis(1,1-dimethylethyl)-4-(1-oxopropyl)phenol	34.31	14035-34-8	262.3871	--	6 w/o Cover	New	PUF	14.4±0.1	61.2±0.9
					8	New	PUF	3.8±0.1	11.9±0.3
					8 w/o Cover	New	PUF	9.0±0.3	32.5±3.6
2-(2-Dimethylaminoethyl)isothiourea	21.26	86114-63-8	147.2418	213	6 w/o Cover	New	PUF	1.3±0.1	14.5±0.5
Dimethylformamide	10.15	68-12-2	73.0938	153	8	New	PUF	18.6±1.8	32.8±2.6
Oxalic acid, bis(2-ethylhexyl) ester	31.64	13675-20-2	314.4601	375	20	New	PUF	2.8±0.1	6.4±0.5
					20 w/o Cover	New	PUF	3.8±0.3	10.5±1.2
1-Decene, 3,4-dimethyl-	31.61	50871-03-9	168.3190	--	2 w/o Cover	New	PUF	31.2±0.9	23.8±1.6
Ethanol, 2-(2-butoxyethoxy)-	23.67	112-34-5	162.2267	231	2 w/o Cover	New	PUF	2.4±0.8	10.1±0.5
Phenol, 2-(1-methylethyl)-	23.93	88-69-7	136.1910	214	2 w/o Cover	New	PUF	5.2±0.6	11.5±1.1
Hexanal	11.04	66-25-1	100.1589	129	9	Used	Poly.	< 1	5.9±1.3
Pentanoic acid	17.82	109-52-4	102.1317	186	9	Used	Poly.	< 1	9.5±2.6
Nonanal	21.15	124-19-6	142.2386	191	6 w/o Cover	New	PUF	< 1	2.3±0.1
					9	Used	Poly.	4.5±0.2	9.6±1.9
					10	Used	PUF	2.0±0.2	3.2±1.2
					11	Used	Poly.	1.2±0.4	2.2±0.2
					12	Used	Poly.	4.3±0.1	7.0±0.3
					17	Used	Poly.	2.0±0.4	3.6±0.5
					18	Used	PUF	1.1±0.4	3.4±0.1
Decanal	23.97	112-31-2	156.2652	208	6 w/o Cover	New	PUF	< 1	1.6±0.1
					9	Used	Poly.	4.7±0.5	10.1±0.9

					19	Used	PUF	1.3±0.2	2.3±0.3
Benzoic acid, 2-ethylhexyl ester	35.94	5444-75-7	250.3334	313	9	Used	Poly.	2.3±0.7	12.2±0.7
Isopropyl Myristate	37.84	110-27-0	270.4507	320	9	Used	Poly.	1.6±0.7	6±0.8
					13	Used	PUF	< 1	5.4±0.3
					15	Used	PUF	< 1	3.3±0.3
					17	Used	Poly.	3.0±0.1	10.6±0.4
					18	Used	PUF	1.5±0.3	5.7±1.0
Palmitic acid	39.69	112-39-0	270.4507	352	9	Used	Poly.	9.7±1.3	42.9±1.4
					10	Used	PUF	2.0±0.2	11.9±1.8
Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)- 2-methyl-1,3-propanediyl ester	33.59	74381-40-1	286.4118	340	10	Used	PUF	1.9±0.1	10.3±2.4
					11	Used	Poly.	1.8±1.3	4.1±0.1
					13	Used	PUF	1.1±0.2	5.1±1
Homosalate	39.4	118-56-9	262.3441	341	11	Used	Poly.	1.3±1.1	3.3±0.1
					17	Used	Poly.	1.9±0.1	8.7±0.3
Octane, 1,1'-oxybis-	34.8	629-82-3	242.4406	287	13	Used	PUF	7.8±1.6	24.2±0.8
					15	Used	PUF	2.5±0.1	7.1±0.4
Isopropyl Palmitate	41.35	142-91-6	298.5038	341	17	Used	Poly.	8.3±0.4	38.7±2.1

¹: All compounds identified with at least 75% match with NIST mass spectral library. SVOCs, with BPs > 240°C, are also presented, however, compounds outside of the hexane to hexadecane range were not included in the TVOC analysis.

²: From NIST Chemistry WebBook.