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2025



# How Do We Redefine Wax Quality for the Candle Industry?

Elizabeth Turner

ExxonMobil

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ORLANDO  
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# Where we left off at NCA'24



## Early Manufacturing

Simple process produces a highly pure wax for food wrappers



## Manufacturing Evolution

Process changes increase yield and efficiency without altering wax quality



## Wax Quality in Candles

Rise in candles creates awareness of wax quality impact on performance



## Defining Wax Quality

US Pharmacopeia and ASTM develop wax quality definition and tests



## Expanding Wax Quality

Public concern is the catalyst for new tests that confirm wax purity



## Future of Wax Quality

What candle trends might shape the next evolution in wax quality?



# Potential wax quality & candle industry trends

## "Free-From" Claims

Chemical of emerging concern in consumer products

## Refillable Container Candles

Emerging candle type driven by changing consumer behaviors

## Biodegradability

Presents an alternative waste disposition for consumers



# How can we further define candle wax quality?

## 01

### Case for Action

#### An analysis of

- Clean beauty industry
- Existing candle claims
- Candle producer technical requests
- Wax quality standards

## 02

### Considerations

#### Create Understanding:

- What is 'free-from'
- Common chemicals of concern
- Advanced wax quality testing

## 03

### Challenges

#### Bring Awareness:

- Establishing industry collaboration
- Proactive identification of emerging chemicals of interest

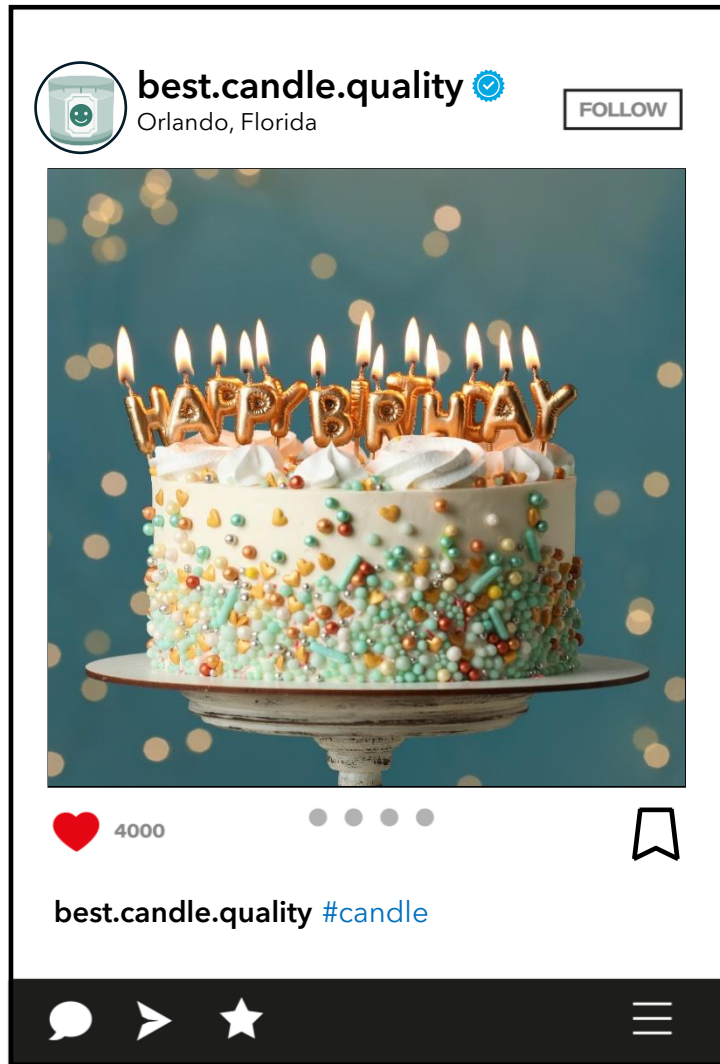
## 04

### Collaboration

#### Let's Start Today!



# Social media and candle quality



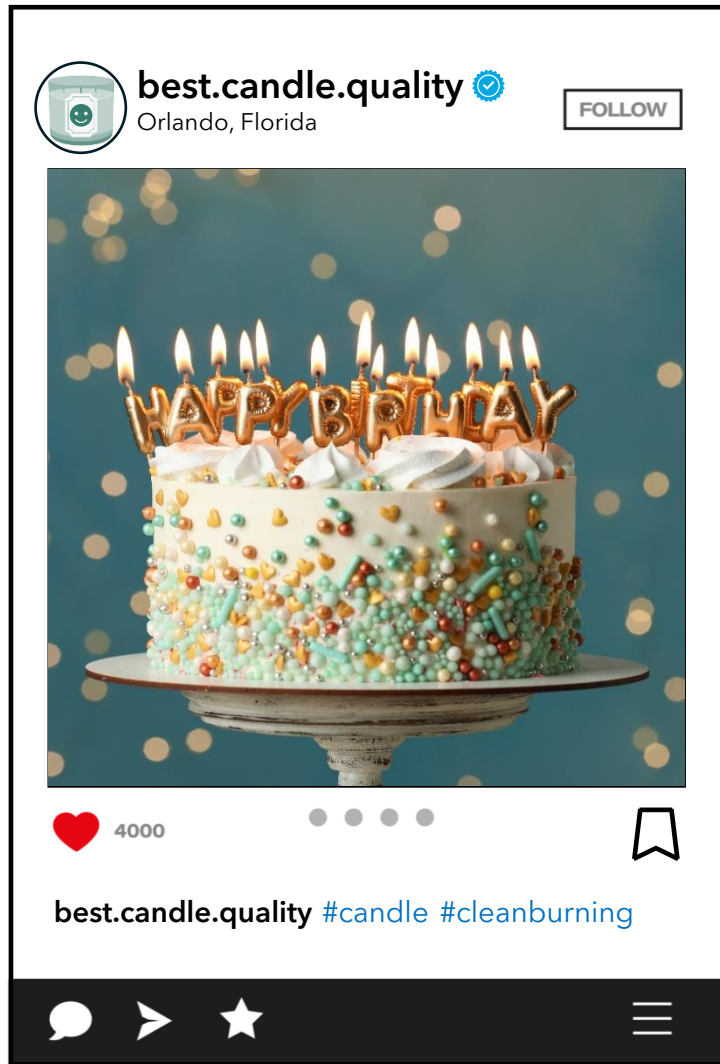
15.7M

#candle

*March 2025 analysis of Instagram hashtags*



# Social media and candle quality

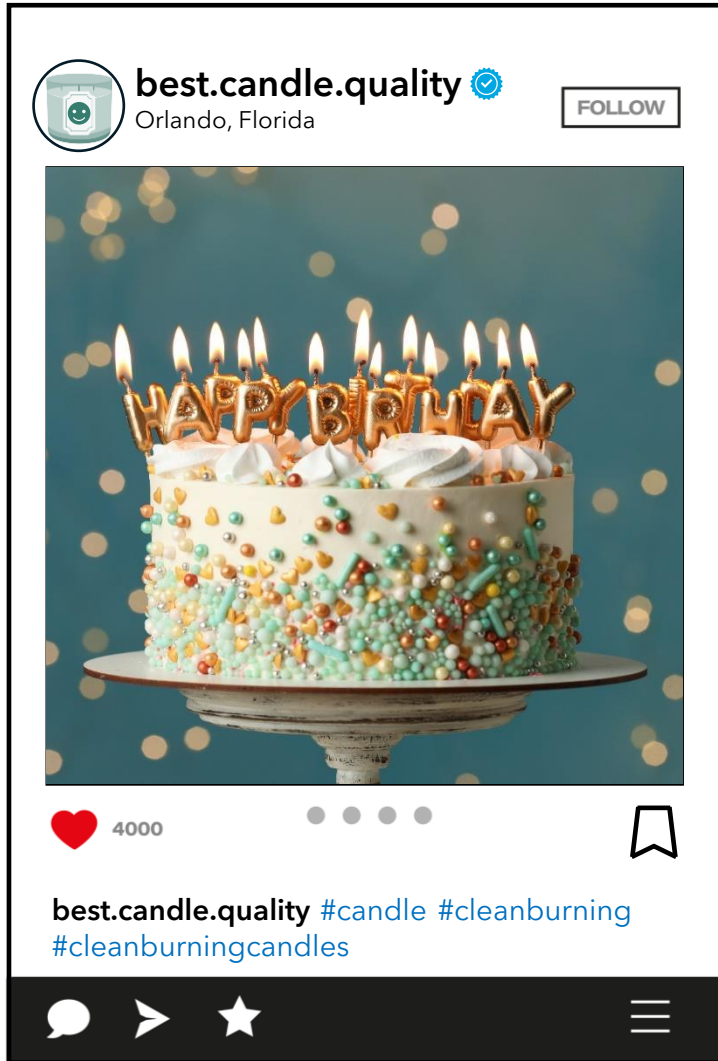


88.5K

#cleanburning

*March 2025 analysis of Instagram hashtags*

# Social media and candle quality

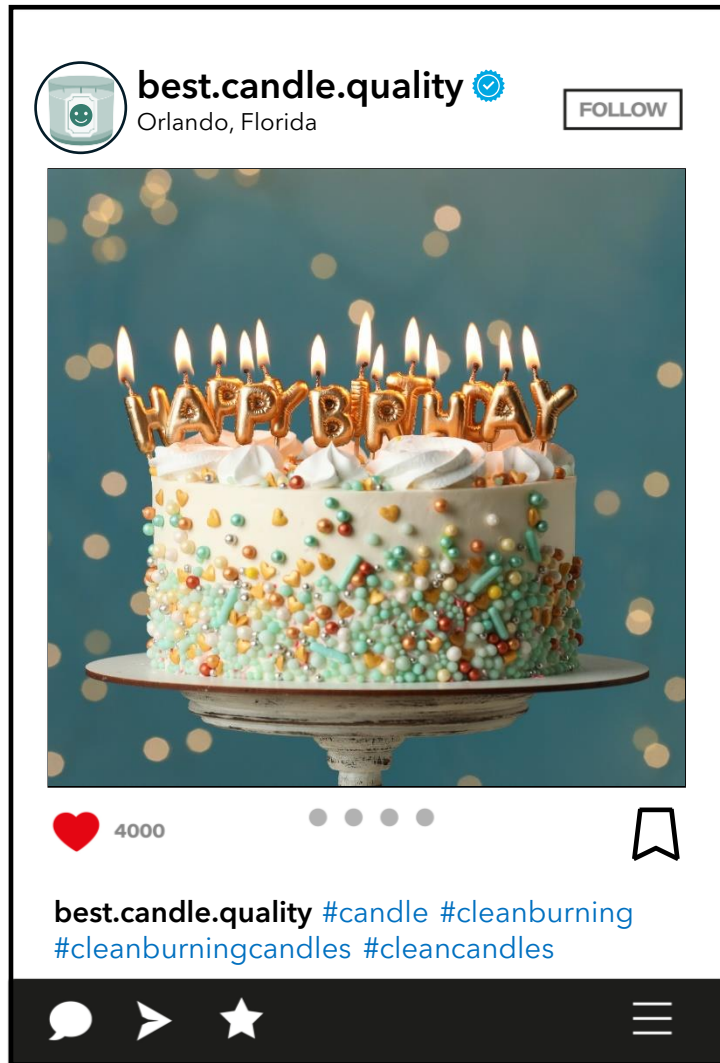


64.1K

#cleanburningcandles

March 2025 analysis of Instagram hashtags

# Social media and candle quality



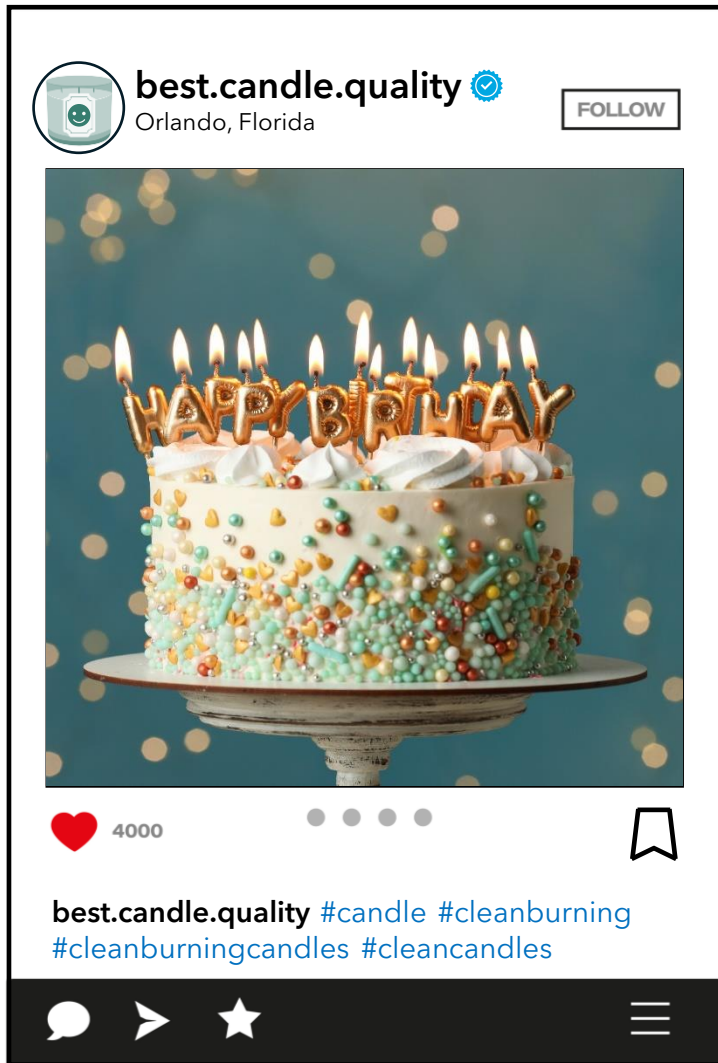
73.2K

#cleancandles

March 2025 analysis of Instagram hashtags



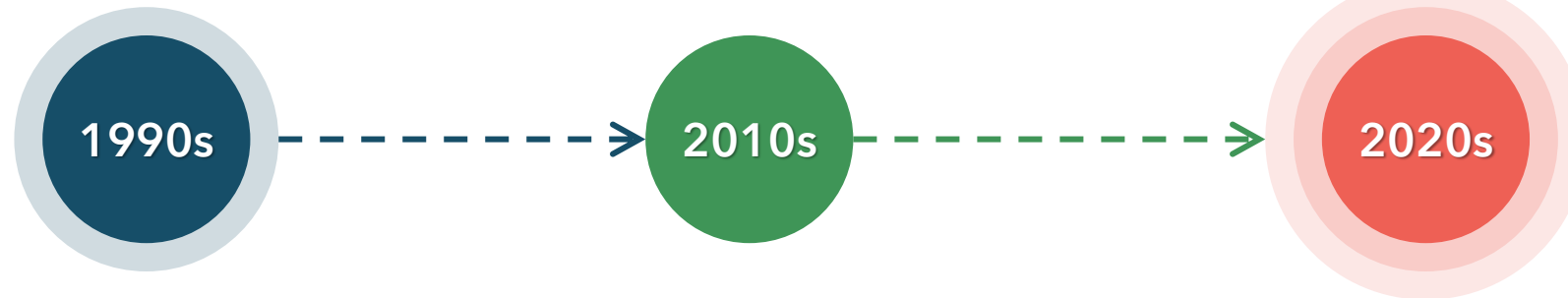
# Social media and candle quality



What does “clean”  
mean to the  
candle consumer?

# How clean beauty came to be

**Niche brands emerge**  
Brands like goop and Detox  
Market are dedicated to  
clean beauty formulations



## The phrase originates

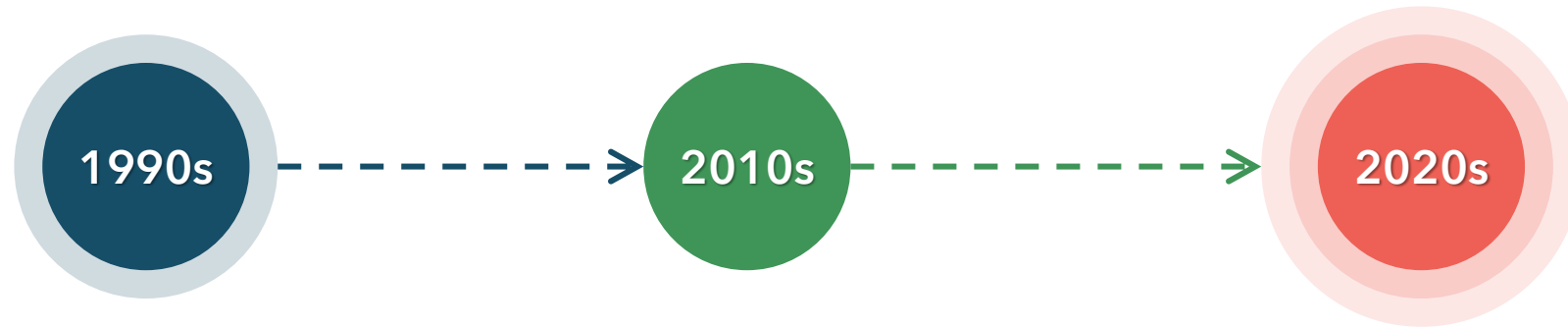
Concept of clean beauty emerges with the 'clean eating' and 'clean living'. Applies to select products primarily at Whole Foods

**Self-regulated frameworks**  
Major beauty retailers like Sephora, Ulta Beauty and Allure create self-determined clean beauty guidelines



# How clean beauty came to be

Clean beauty does not necessarily imply natural



*Evolution of clean beauty definition*

**Natural based**

**Scientifically derived**





# How clean beauty came to be

Clean beauty does not necessarily imply natural

## Generally Clean Beauty:

- 1 Applies to **cosmetics** & **personal care**
- 2 Implies product **ingredient safety**

Irritants or allergens

Endocrine disruptors

Potential carcinogens



# How clean beauty came to be

Clean beauty does not necessarily imply natural

## Generally Clean Beauty:

- 1 Applies to **cosmetics** & **personal care**
- 2 Implies product **ingredient safety**
- 3 Provides **ingredient transparency**
- 4 Promote **eco-friendly production** & packaging

The word “clean” and the frameworks for clean beauty **are not industry regulated**



# How clean beauty relates to candles

Some **beauty retailers** also offer candles to which clean beauty frameworks are applied

# 25%

Candles found online are **designated clean\*** by respective framework

# 38%

Candles found online are described as **clean burning\***

*\*March 2025 analysis of a specific beauty retailer*





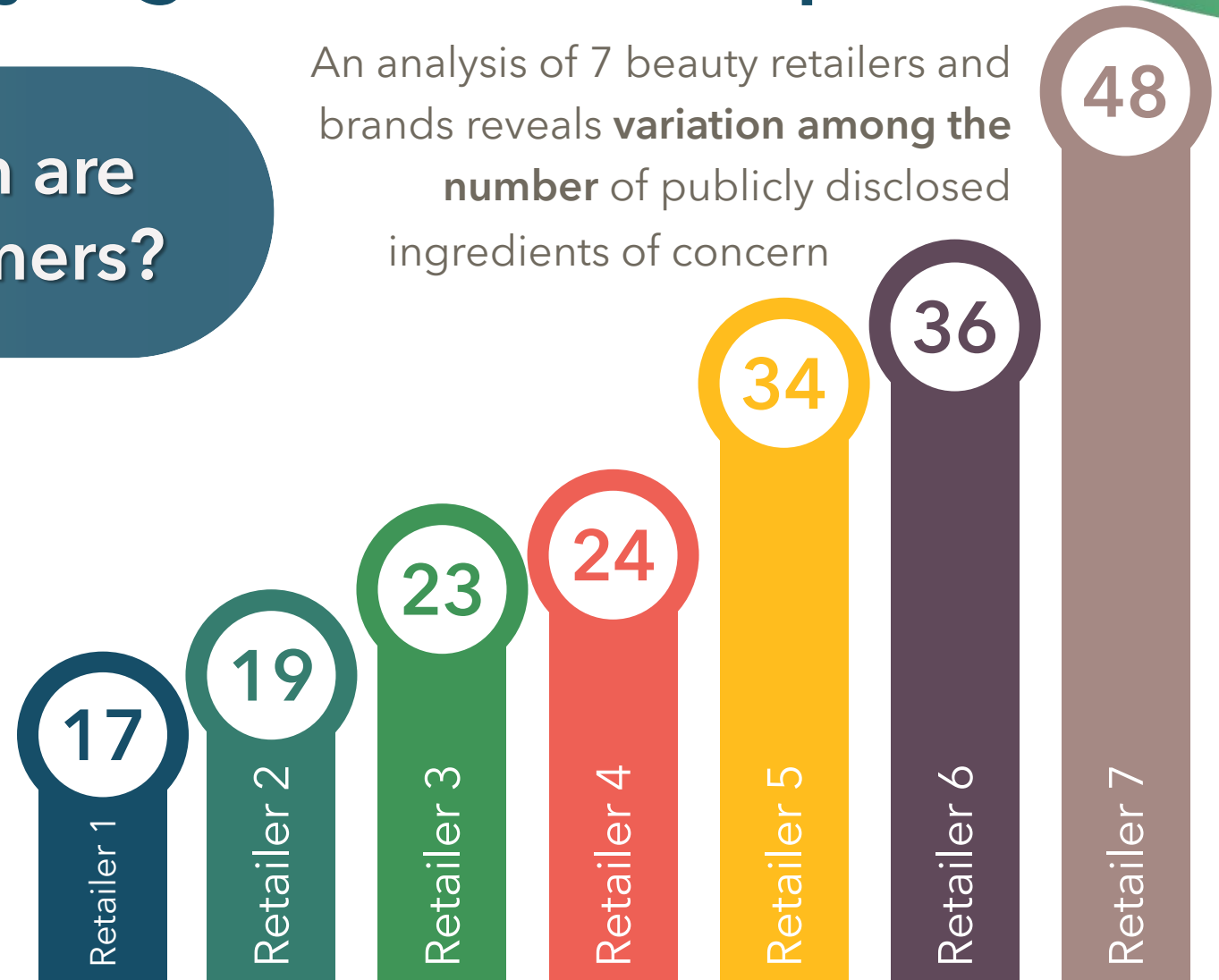
# Navigating clean beauty ingredient landscape

What ingredients of concern are publicly disclosed to consumers?

36

Chemicals of concern identified by the  
**Campaign for Safe Cosmetics**

An analysis of 7 beauty retailers and brands reveals **variation among the number** of publicly disclosed ingredients of concern



# Navigating clean beauty ingredient landscape

What ingredients of concern are publicly disclosed to consumers?

90

Aluminum compounds  
Ethoxylated Ingredients  
Carbon black or black 2 (nanomaterial)  
Emulsifying Wax  
Non-Transparent Synthetic Fragrance  
Ceteareth-20  
Triclosan  
Homosalate  
Acetone  
Bisphenol A (BPA)  
Animal Derived Ingredients  
Petrolatum & Paraffin  
Resorcinol  
Heavy Metals [Pb, Ni, Cd etc.]  
Silicones  
Methylisothiazolinone (MIT)  
Cyclotetrasiloxane (D4)  
BHT (Butylated Hydroxytoluene)  
Cadmium [ 3 ppm]  
Fragrances  
Coal Tar  
Alkylphenol Ethoxylates  
Polycyclic Musk  
Titanium dioxide  
Benzophenones & related compounds  
Methylchloro  
Glutaral  
Synthetic fragrance  
p-Phenylenediamine  
Polysorbate-20  
Acetaldehyde  
Mineral oil  
Benzene  
Ethylenediaminetetraacetic (EDTA) & derivatives  
Methylene chloride  
Latex  
Dioxin  
Acetonitrile  
Methoxyethanol or methyl cellosolve  
Polyethylene glycol (PEG compounds)  
Phthalates  
Butoxyethanol  
Styrene & styrene oxide  
Sodium Lauryl Sulfate & Sodium Laureth Sulfate  
Nitromusks  
Perfluorinated compounds (PTFE, PFAS, PFOA, PFOS)  
Oxybenzone  
Ethanolamines: Mica  
Formaldehyde  
Benzyl Alcohol  
Benzalkonium chloride  
Nanomaterials  
Ethylene oxide  
Acrylamide and polyacrylamide  
Triclocarban  
Phenoxyethanol  
Polyacrylamide  
Mercury & mercury compounds (thimerisol)  
DEA/TEA/MEA/ETA  
PABA (Para-aminobenzoic acid)  
Antimony [ 5 ppm]  
Octinoxate  
Acrylates  
Ammonium Laureth Sulfate  
Zinc Chloride  
Zinc Oxide  
Aluminum powder  
Cyclic silicones  
Quaternary Ammonium Compounds  
Tertiary butylhydroquinone  
Lead [ 5ppm, 10 ppm is trace]  
Triphenylphosphate (TPP)  
Aluminum salts  
Alkylphenols (Octylphenols, nonylphenols)  
Siloxanes  
Retinol & Retinol Compounds  
Black 3  
1,4-dioxane  
Parabens  
Formaldehyde releasing agents  
Hydroquinone  
BHA (Butylated Hydroxyanisole)

Ingredients of concern are collectively and publicly disclosed by 7 different retailers with 'Clean Beauty' frameworks

# Some retailer claims on candles

Regardless of clean designation; candles can also be described with **various formulation attributes**

## Beauty Retailer A\*



*\*March 2025 analysis of a specific beauty retailer*



Based on the candle producing attendees  
of the 2025 World Candle Congress



24%

Define wax ingredient choice  
as **food-grade approved**



21%

Define wax ingredient choice  
as a **premium wax**



# Based on the candle producing attendees of the 2025 World Candle Congress



## 71%

That reference using FDA  
grade wax **do not make  
any "free-from" claims**



## 50%

That state using a premium  
wax also **have at least one  
"free-from" claim**



Based on the candle producing attendees  
of the 2025 World Candle Congress

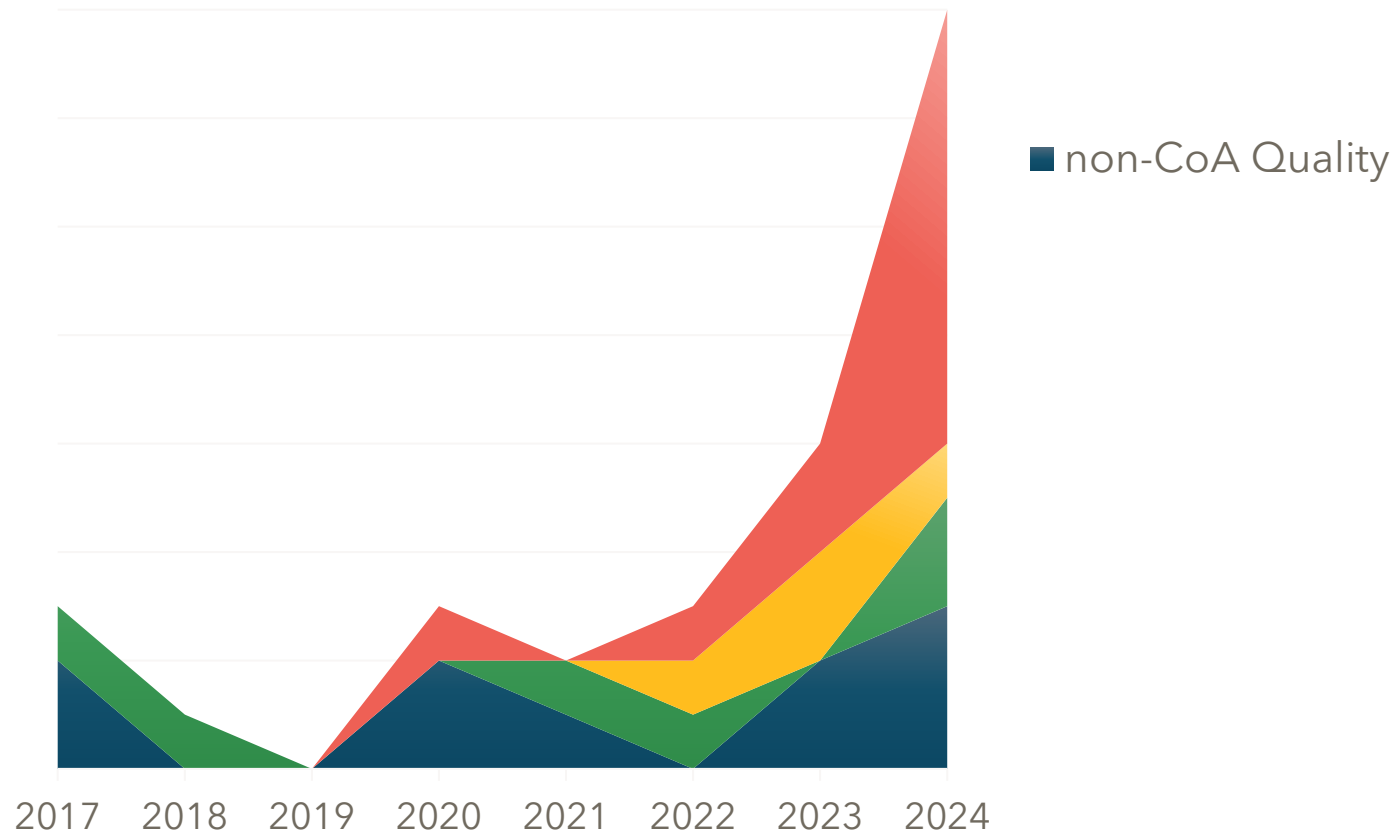
What does **premium  
wax** mean to the  
candle consumer?





# Candle producer wax quality requests

## Candle Manufacturers Requests to Wax Producer for Technical Information\*



## non-Certificate of Analysis Wax Qualities

Generally singular quality  
or composition request  
for wax

Carbon number distribution

Aromatics

non-Specific heavy metals

Sulfur

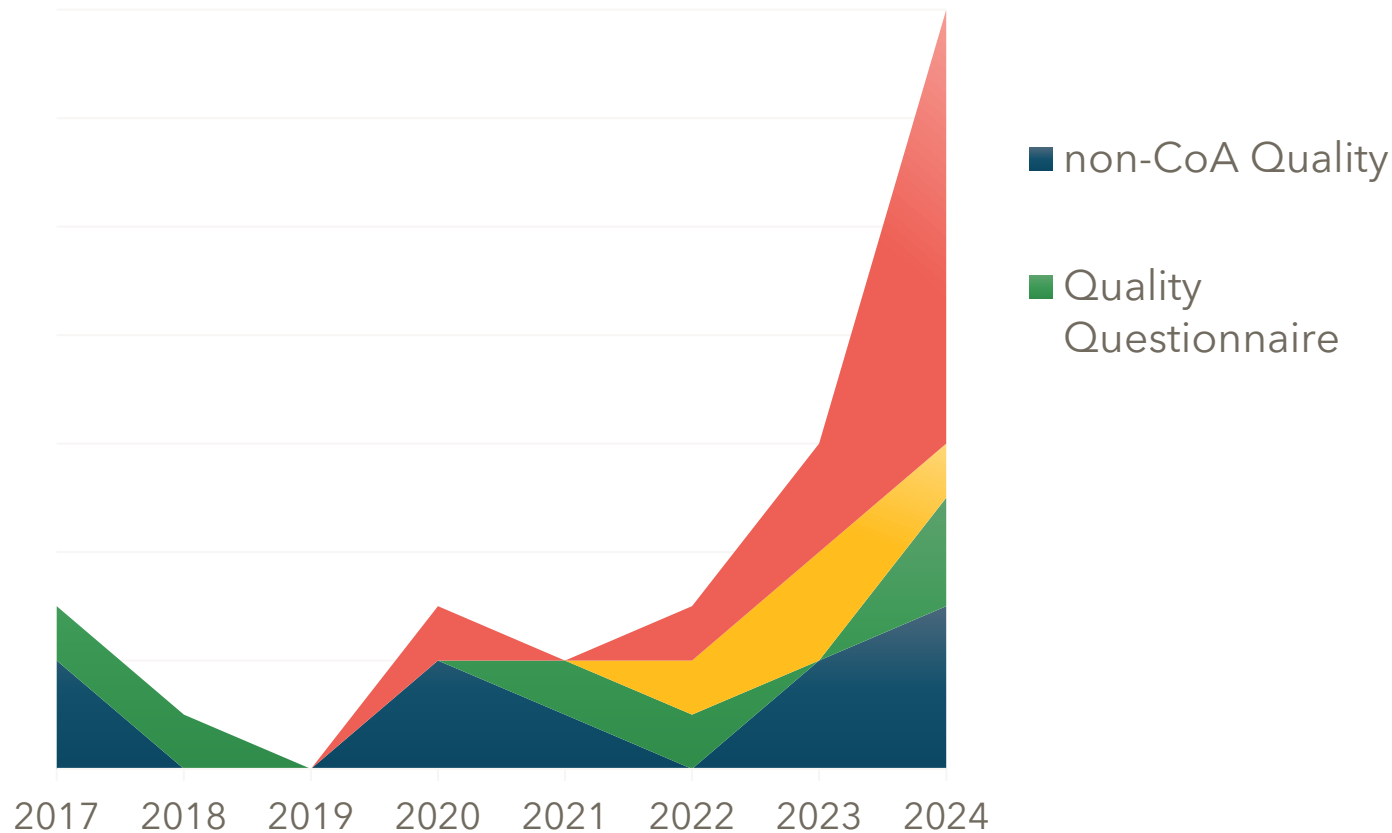
Conflict minerals

Phthalates

Parabens

# Candle producer wax quality requests

Candle Manufacturers Requests to Wax Producer for Technical Information\*



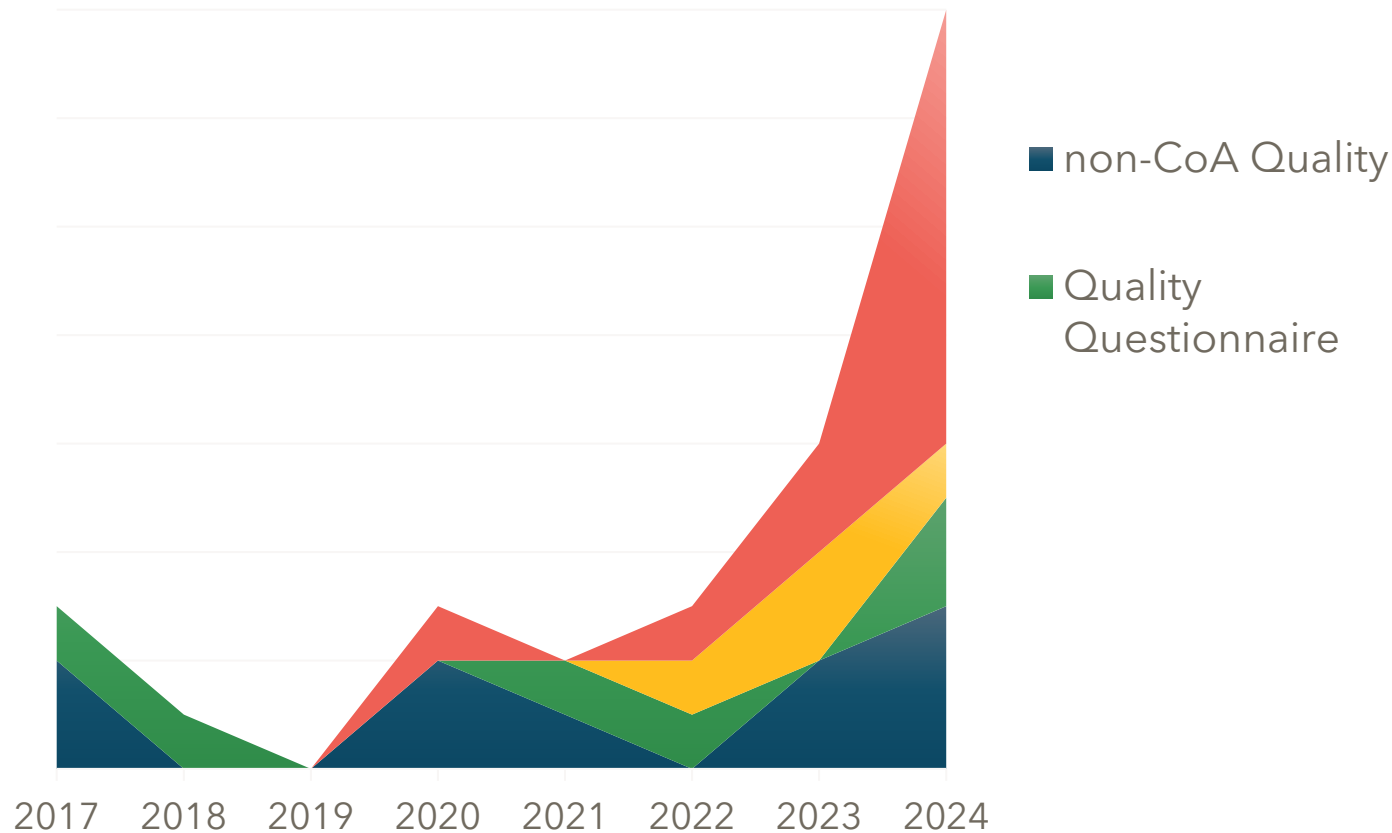
## Quality Questionnaires

Vary by customer and cover a wide breath of qualities and ingredients of concern

**50** Ingredients or qualities represented collectively among questionnaires

# Candle producer wax quality requests

## Candle Manufacturers Requests to Wax Producer for Technical Information\*



## Quality Questionnaires

Vary by customer and cover a wide breath of qualities and ingredients of concern

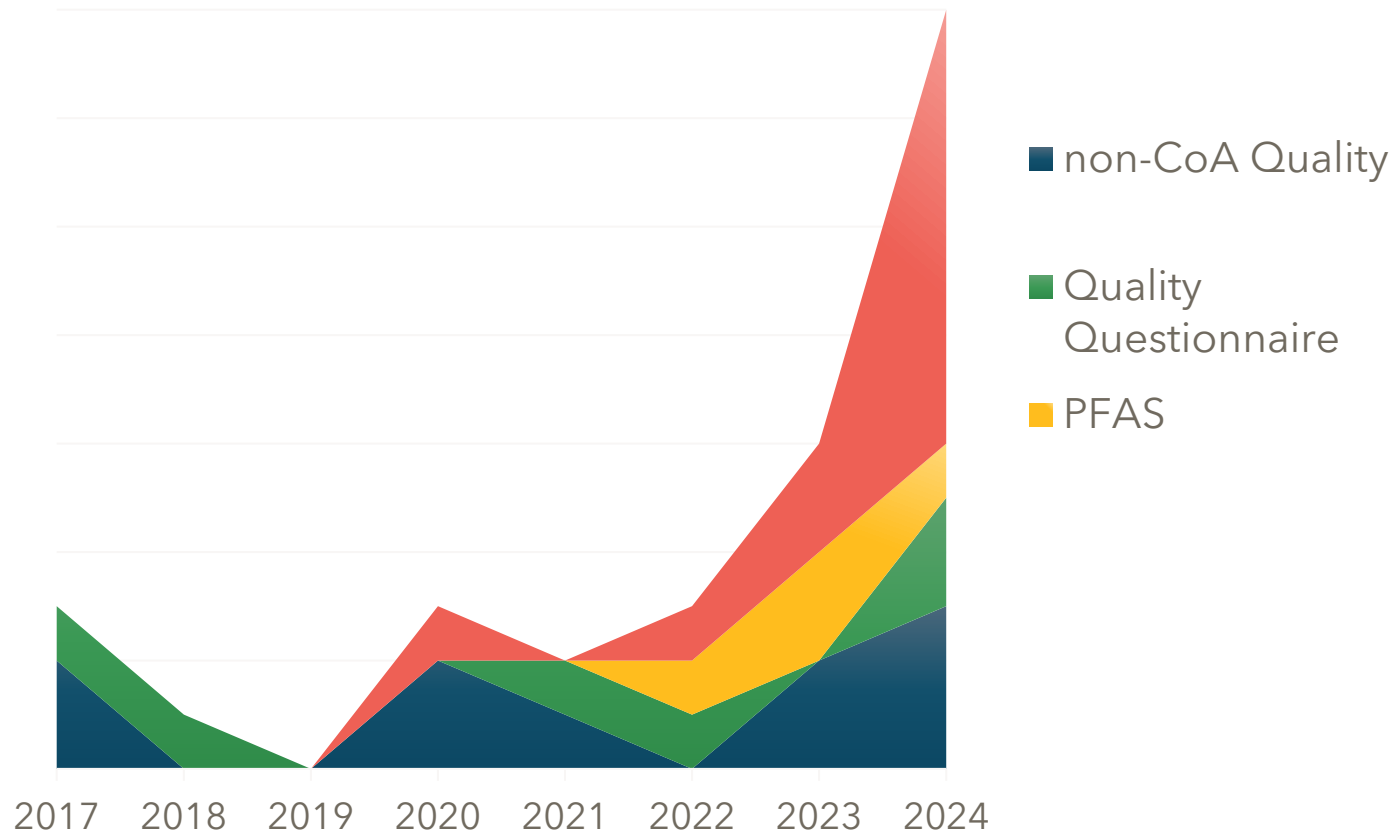
May or may not indicate tolerances for trace contamination

Often include regulatory component



# Candle producer wax quality requests

## Candle Manufacturers Requests to Wax Producer for Technical Information\*



## Per- and polyfluoroalkyl substances [PFAS]

Synthetic organofluorine compounds known as 'forever chemicals'

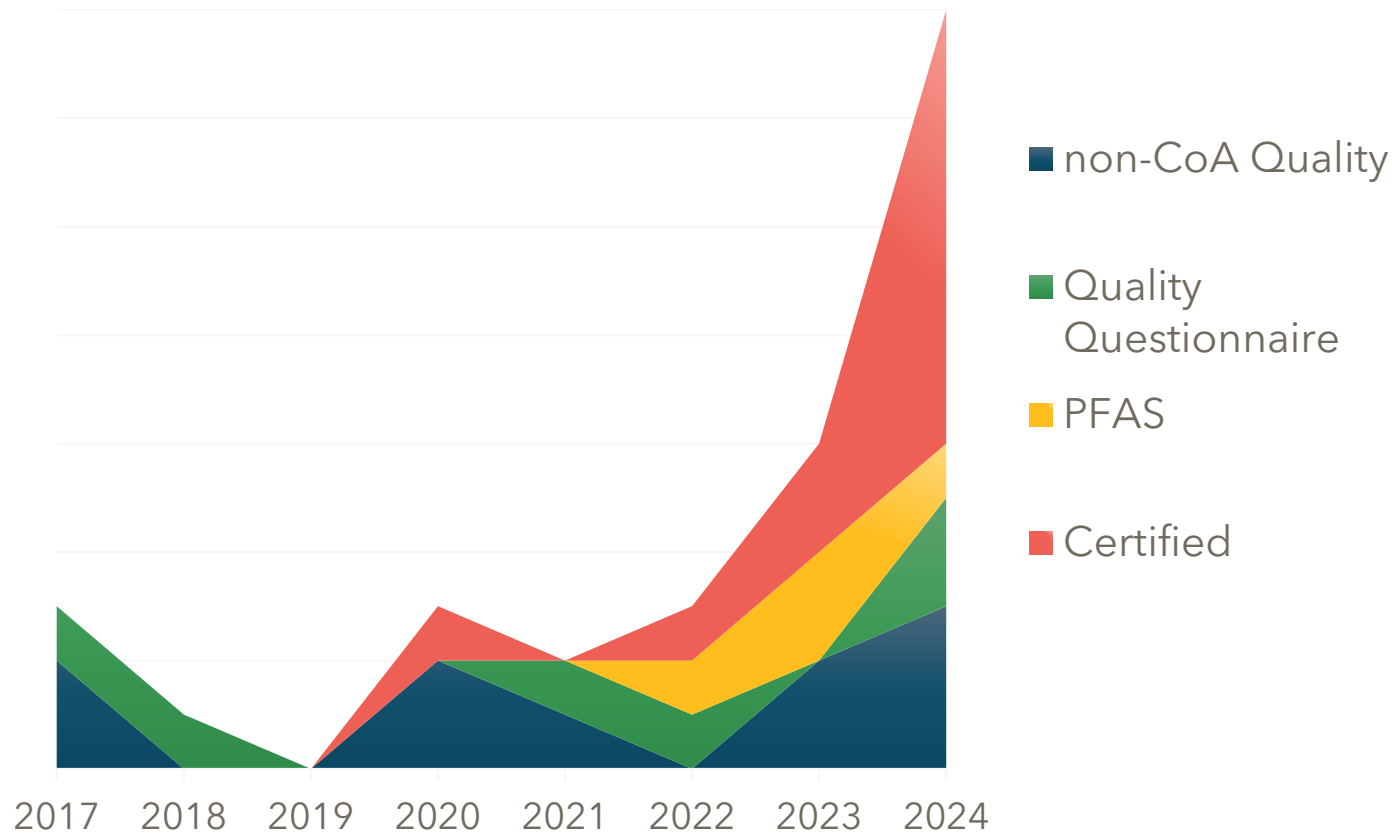
Provide water and oil repellency

Some state regulations were enacted since 2023

No specific PFAS in candle regulations exist today

# Candle producer wax quality requests

## Candle Manufacturers Requests to Wax Producer for Technical Information\*



\*Data based on global technical requests to ExxonMobil wax

## Certified Wax Quality

Vegan and Leaping Bunny certification were most requested in 2024

Candle producers are interested in other certifications as well



# Existing wax quality standards

## US food grade approved wax

21 CFR 172.886 & 21 CFR 178.3710: Petroleum paraffin wax

1 **Composition:** a mixture of solid hydrocarbons, paraffinic in nature

2 **UV Absorbance** does not exceed stated limits

280 - 289 nm	0.15
290 - 299 nm	0.12
300 - 359 nm	0.08
360 - 400 nm	0.02

3 *may* contain a **food grade anti-oxidant**

4 *may* contain a **food grade processing aid**

5 *may* contain <0.01 wt% **UV absorber**

6 *may* contain <1 wt% **residues in processing aids**

Indirect Use Only





# Existing wax quality standards

## US food grade approved wax

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1 **Composition:** a mixture of solid hydrocarbons, paraffinic in nature

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5 *may* contain <0.01 wt% **UV absorber**

6 *may* contain <1 wt% **residues in processing aids**

**Good manufacturing  
practices also apply**

# Existing wax quality standards

## US Pharmaceutical grade wax

*U.S National Formulary: Petroleum paraffin wax*

### Conforms to Composition



Mixture of solid saturated hydrocarbons, **verified by IR spectroscopy**  
May contain **a suitable antioxidant**  
Congealing Point:  
**47 - 65°C**

### Meets Purity



Passes qualitative tests for **acidity, alkalinity** and **readily carbonizable substances**

### Absence of Impurity



Passes qualitative test for absence of **sulfur**.  
Meets or is lower than UV absorbance requirements for **polycyclic aromatic hydrocarbons**



# Existing wax quality standards

## RAL candle quality standard

RAL GZ-041

Mark indicates reliable **candle quality** with **no soot or smoke** made with **quality-certified raw materials**

1

Define **burning requirements** for various candle types

2

Define **raw material quality specifications** for all parts of the candle system:  
paraffin, stearin, beeswax, fat & oils, wicks, dyes, varnish, fragrances



# Existing wax quality standards

## RAL candle quality standard

RAL GZ-041

### RAL quality requirements for paraffin wax

						
Color	Sulfur	Benzene Toluene	Lead	Ash	PAH	UV Stability
Minimum Saybolt 24	Maximum 20 ppm	Toluene < 5 ppm Benzene <0.5 ppm	Maximum 0.2 ppm	Maximum 0.1 wt%	Less than FDA maxima	Minimum Saybolt 5 or 15



# A case for action:



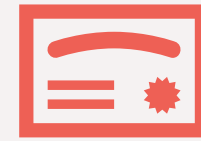
## Consumers

becoming increasingly aware of ingredient usage in consumer goods, **including candles**



## Ingredients

**absence of industry alignment** leads to complex ingredients of concern frameworks



## Certification

recent increase in requests for additional and **advanced wax quality certification**



## Wax Purity

existing **wax quality standards differ** in defining purity and don't include emerging needs

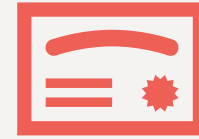
# A case for action:



Consumers



Ingredients



Certification



Wax Purity

This supports a collective discussion to better and scientifically define future candle wax purity needs



# 02 Considerations

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# What does "free-from" mean?

Can be also be phrased:

1

Free of [X]

5

Does not include [X]

2

Absence of [X]

6

Made without [X]

3

Contains no [X]

7

[X] - free

4

Does not contain [X]

8

0% [X]

[X] = *ingredient*

# What does "free-from" mean?

## United States

21 CFR 260.9

*specific free-of claim regulations*

- 1 claims should be clearly and prominently **qualified** to avoid deception
- 2 a truthful claim may be deceptive if the substance is **not associated** with the product
- 3 claim may be appropriate even for products that **contain a trace amount** of a substance

## Europe

Commission Regulation EC 655/2013

*common criteria for the justification of claims used in cosmetics*

- 1 Legal Compliance 4 Honesty
- 2 Truthfulness 5 Fairness
- 3 Evidential Support 6 Informed Decision Making

# What does "free-from" mean?

With growing consumer awareness and existing "free-from" regulations how can we **substantiate candle wax quality**

What **chemicals of concern** are relevant to candle wax?

Can **trace contamination tolerances** be determined?

Can these potential contaminants be measured?

What testing frequency is needed for purity?



# Considerations when analyzing wax

Few analytical methods can be conducted in the **solid state**



Paraffinic wax has **limited solubility** in organic solvents



Awareness of **proper wax sampling** techniques



# Current candle claims vs wax quality

## PFAS

Per- & polyfluoroalkyl substances

### Tolerance

ECHA "PFAS-free" proposal:

**Total organic fluorine < 50 ppm**

Individual PFAS < 25 ppb

Sum of individual PFAS < 250 ppb

**BPI Composability < 100 ppm Total Fluorine**

## What are they?

### Persistent in the environment

Over 14, 000 chemicals

*"Exposure to certain PFAS may lead to adverse health outcomes"\**

EPA has designated PFOA and PFOS as hazardous substances

## Measurable

PFAS testing includes targeted analysis & total organic fluorine

Wax analyzed for **Total Fluorine**

Requires oxygen combustion of wax prior to ASTM D1179

Limited 3P studies show Total Fluorine values in paraffin wax **between 1 - 3.5 ppm**

*Still investigating method for Total Organic Fluorine*

\*According to the EPA [Our Current Understanding of the Human Health and Environmental Risks of PFAS](#) | US EPA

# Current candle claims vs wax quality

## Phthalates

### Tolerance

On-going studies, new limitations may be proposed

REACH SVHC Lists **14 phthalates**

Under REACH must be **<0.1 wt%**

### What are they?

Group of chemicals give flexibility to plastics

Named **"everywhere chemicals"** as they can leach from products

Not all phthalates pose a risk to health or the environment

*Some ortho-phthalates are restricted globally\**

### Measurable

**ISO 14389 GCMS\*\***  
phthalate method  
assessed for wax

Analysis of **23 different phthalates** including 11 of the 14 REACH SVHC phthalates

Initial 3P analysis **shows low levels of select phthalates** in some paraffin waxes; applicability still to be verified

\* According to ECHA [Phthalates - ECHA](#)

\*\* Method still being assessed for wax applicability; testing conducted on limited number of samples by 3P lab

# Current candle claims vs wax quality

## Parabens

### Tolerance

On-going studies new limitations may be proposed

In Europe cosmetics\*:

Shorter chain parabens  
**[Me, Et] 0.4 wt%**

Longer chain parabens  
**[Pr, Bu] 0.19 wt%**

### What are they?

Class of chemicals used as preservatives

Some studies have shown parabens cause low level hormone-like activity

**Health risk likely increases with longer alkyl chain**

*Some longer chain parabens have been restricted in EU*

### Measurable

Used a chromatography method\*\* for cosmetics

Analysis of **6 different parabens** [R: C1 - C4]

Method has low limit of detection 0.15 - 1.5 ppm

*However, matrix interferences of paraffin wax molecules inhibit ability to detect butyl & iso-butyl paraben*

\* According to [citizens parabens en.pdf](#)

\*\* Method still being assessed for wax applicability; testing conducted on limited number of samples by 3P lab



# Current candle claims vs wax quality

## Sulfates

### Tolerance

SLS /SLES have not been restricted in cosmetics in EU or US

Can be used in products up to **1 wt%**

### What are they?

In clean beauty this commonly refers to **sodium lauryl sulfate** (SLS) and **sodium laureth sulfate** (SLES)

Used as a surfactant

Early study suggested human health concern but since disproven\*

Some sulfates may cause irritation

### Measurable

Used an aqueous analysis method USP 221\*\* for pharmaceuticals

**Qualitative determination of non-specific sulfates**

*Based on 3P lab analysis no sulfates were detected in all waxes tested*

\* According to [Exploring EU regulations: SLS in cosmetics](#)  
\*\* Method still being assessed for wax applicability; testing conducted on limited number of samples by 3P lab

# Current candle claims vs wax quality

	Relevant*	Tolerance‡	Measurable**
<div>PFAS</div> <div>Per- &amp; polyfluoroalkyl substances</div>	✓	✓	?
Phthalates	?	✓	?
Parabens	?	✓	?
Sulfates	✗	✓	?

\***Relevant** related to consumer and candle producer need; no known studies on candles can be used to inform relevance at this time

‡**Tolerance** based on known and /or proposed limits for some consumer goods, does not imply the limit would be applied to candle wax

\*\* Methods still being assessed for wax applicability



# Potential advanced attributes of wax purity

Aspects of clean beauty and candle producer requests **relevant to wax**

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2025





# Potential advanced attributes of wax purity

Antimony (Sb)

Arsenic (As)

Ash

Barium (Ba)

Benzene

Butylated Hydroxytoluene

Cadmium (Cd)

Chromium (Cr)

Cobalt (Co)

Heavy Metals

Lead-soluble (Pb)

Lead-total (Pb)

Mercury (Hg)

Mercury compounds (thimerisol)

Methyl Ethyl Ketone

Methyl Isobutyl Ketone

Molybdenum (Mo)

Nickel (Ni)

Odor

Polyaromatic hydrocarbons

Saybolt color

Selenium (Se)

Sulfur

Toluene

UV absorbers

Volatile Organic Compounds

Zinc (Zn)





# Metals analysis in paraffin wax

1 IA																		18 VIIIA	
1 H Hydrogen 1.008																		2 He Helium 4.0026	
3 Li Lithium 6.94	2 IIA																		
4 Be Beryllium 9.0122																			
<div>Atomic Number → 1</div> <div>Symbol ← H</div> <div>Name → Hydrogen</div> <div>Atomic Weight ← 1.008</div>																			
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminium 26.982	14 Si Silicon 28.085	15 P Phosphorus 30.974	16 S Sulphur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948		
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798		
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29		
55 Cs Caesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides		72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)	
87 Fr Francium (223)	88 Ra Radium (226)	89-103 Actinides		104 Rf Rutherfordium (261)	105 Db Dubnium (268)	106 Sg Seaborgium (269)	107 Bh Bohrium (270)	108 Hs Hassium (277)	109 Mt Meitnerium (278)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (282)	112 Cn Copernicium (285)	113 Nh Nihonium (286)	114 Fl Flerovium (289)	115 Mc Moscovium (290)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)	
<div>57 La Lanthanum 138.91</div> <div>58 Ce Cerium 140.12</div> <div>59 Pr Praseodymium 140.91</div> <div>60 Nd Neodymium 144.24</div> <div>61 Pm Promethium (145)</div> <div>62 Sm Samarium 150.36</div> <div>63 Eu Europium 151.96</div> <div>64 Gd Gadolinium 157.25</div> <div>65 Tb Terbium 158.93</div> <div>66 Dy Dysprosium 162.50</div> <div>67 Ho Holmium 164.93</div> <div>68 Er Erbium 167.26</div> <div>69 Tm Thulium 168.93</div> <div>70 Yb Ytterbium 173.05</div> <div>71 Lu Lutetium 174.97</div>																			
<div>89 Ac Actinium (227)</div> <div>90 Th Thorium 232.04</div> <div>91 Pa Protactinium 231.04</div> <div>92 U Uranium 238.03</div> <div>93 Np Neptunium (237)</div> <div>94 Pu Plutonium (244)</div> <div>95 Am Americium (243)</div> <div>96 Cm Curium (247)</div> <div>97 Bk Berkelium (247)</div> <div>98 Cf Californium (251)</div> <div>99 Es Einsteinium (252)</div> <div>100 Fm Fermium (257)</div> <div>101 Md Mendelevium (258)</div> <div>102 No Nobelium (259)</div> <div>103 Lr Lawrencium (260)</div>																			



Element of interest based on  
candle producer requests

# Metals analysis in paraffin wax

IA																		VIIIA																	
1 H Hydrogen 1.008																		2 He Helium 4.0026																	
2 IIA																																			
3 Li Lithium 6.94																		4 Be Beryllium 9.0122																	
11 Na Sodium 22.990																		12 Mg Magnesium 24.305																	
3 IIIB																		4 IVB																	
19 K Potassium 39.098																		20 Ca Calcium 40.078																	
21 Sc Scandium 44.956																		22 Ti Titanium 47.867																	
23 V Vanadium 50.942																		24 Cr Chromium 51.996																	
25 Mn Manganese 54.938																		26 Fe Iron 55.845																	
27 Co Cobalt 58.933																		28 Ni Nickel 58.693																	
29 Cu Copper 63.546																		30 Zn Zinc 65.38																	
31 Ga Gallium 69.723																		32 Ge Germanium 72.630																	
33 As Arsenic 74.922																		34 Se Selenium 78.971																	
35 Br Bromine 79.904																		36 Kr Krypton 83.798																	
37 Rb Rubidium 85.468																		38 Sr Strontium 87.62																	
39 Y Yttrium 88.906																		40 Zr Zirconium 91.224																	
41 Nb Niobium 92.906																		42 Mo Molybdenum 95.95																	
43 Tc Technetium (98)																		44 Ru Ruthenium 101.07																	
45 Rh Rhodium 102.91																		46 Pd Palladium 106.42																	
47 Ag Silver 107.87																		48 Cd Cadmium 112.41																	
49 In Indium 114.82																		50 Sn Tin 118.71																	
51 Sb Antimony 121.76																		52 Te Tellurium 127.60																	
53 I Iodine 126.90																		54 Xe Xenon 131.29																	
55 Cs Caesium 132.91																		56 Ba Barium 137.33																	
57-71 Lanthanides																		72 Hf Hafnium 178.49																	
73 Ta Tantalum 180.95																		74 W Tungsten 183.84																	
75 Re Rhenium 186.21																		76 Os Osmium 190.23																	
77 Ir Iridium 192.22																		78 Pt Platinum 195.08																	
79 Au Gold 196.97																		80 Hg Mercury 200.59																	
81 Tl Thallium 204.38																		82 Pb Lead 207.2																	
83 Bi Bismuth 208.98																		84 Po Polonium (209)																	
85 At Astatine (210)																		86 Rn Radon (222)																	
87 Fr Francium (223)																		88 Ra Radium (226)																	
89-103 Actinides																		104 Rf Rutherfordium (261)																	
105 Db Dubnium (268)																		106 Sg Seaborgium (269)																	
107 Bh Bohrium (270)																		108 Hs Hassium (277)																	
109 Mt Meitnerium (278)																		110 Ds Darmstadtium (281)																	
111 Rg Roentgenium (282)																		112 Cn Copernicium (285)																	
113 Nh Nihonium (286)																		114 Fl Flerovium (289)																	
115 Mc Moscovium (290)																		116 Lv Livermorium (293)																	
117 Ts Tennessine (294)																		118 Og Oganesson (294)																	
57 La Lanthanum 138.91																		58 Ce Cerium 140.12																	
59 Pr Praseodymium 140.91																		60 Nd Neodymium 144.24																	
61 Pm Promethium (145)																		62 Sm Samarium 150.36																	
63 Eu Europium 151.96																		64 Gd Gadolinium 157.25																	
65 Tb Terbium 158.93																		66 Dy Dysprosium 162.50																	
67 Ho Holmium 164.93																		68 Er Erbium 167.26																	
69 Tm Thulium 168.93																		70 Yb Ytterbium 173.05																	
71 Lu Lutetium 174.97																																			
89 Ac Actinium (227)																		90 Th Thorium 232.04																	
91 Pa Protactinium 231.04																		92 U Uranium 238.03																	
93 Np Neptunium (237)																		94 Pu Plutonium (244)																	
95 Am Americium (243)																		96 Cm Curium (247)																	
97 Bk Berkelium (247)																		98 Cf Californium (251)																	
99 Es Einsteinium (252)																		100 Fm Fermium (257)																	
101 Md Mendelevium (258)																		102 No Nobelium (259)																	
103 Lr Lawrencium (260)																																			

Atomic Number →

1

← Symbol

← Atomic Weight

Name →

Hydrogen

Atomic Number → 1  
Symbol ← H  
Name → Hydrogen  
Atomic Weight ← 1.008

## Toxics in Packaging

Clearinghouse maintains  
legislation for intentional and  
incidentally introduced

Mercury [Hg]

Cadmium [Cd]

Lead [Pb]

Hexavalent Chromium [Cr<sup>6+</sup>]

Shall not exceed 100 ppm



Element of interest based on  
candle producer requests

# Metals analysis in paraffin wax

IA																		VIIIA																	
1 H Hydrogen 1.008																		2 He Helium 4.0026																	
3 Li Lithium 6.94		4 Be Beryllium 9.0122																13 B Boron 10.81		14 C Carbon 12.011		15 N Nitrogen 14.007		16 O Oxygen 15.999		17 F Fluorine 18.998		18 Ne Neon 20.180							
11 Na Sodium 22.990		12 Mg Magnesium 24.305																13 Al Aluminium 26.982		14 Si Silicon 28.085		15 P Phosphorus 30.974		16 S Sulphur 32.06		17 Cl Chlorine 35.45		18 Ar Argon 39.948							
19 K Potassium 39.098		20 Ca Calcium 40.078		21 Sc Scandium 44.956		22 Ti Titanium 47.867		23 V Vanadium 50.942		24 Cr Chromium 51.996		25 Mn Manganese 54.938		26 Fe Iron 55.845		27 Co Cobalt 58.933		28 Ni Nickel 58.693		29 Cu Copper 63.546		30 Zn Zinc 65.38		31 Ga Gallium 69.723		32 Ge Germanium 72.630		33 As Arsenic 74.922		34 Se Selenium 78.971		35 Br Bromine 79.904		36 Kr Krypton 83.798	
37 Rb Rubidium 85.468		38 Sr Strontium 87.62		39 Y Yttrium 88.906		40 Zr Zirconium 91.224		41 Nb Niobium 92.906		42 Mo Molybdenum 95.95		43 Tc Technetium (98)		44 Ru Ruthenium 101.07		45 Rh Rhodium 102.91		46 Pd Palladium 106.42		47 Ag Silver 107.87		48 Cd Cadmium 112.41		49 In Indium 114.82		50 Sn Tin 118.71		51 Sb Antimony 121.76		52 Te Tellurium 127.60		53 I Iodine 126.90		54 Xe Xenon 131.29	
55 Cs Caesium 132.91		56 Ba Barium 137.33		57-71 Lanthanides		72 Hf Hafnium 178.49		73 Ta Tantalum 180.95		74 W Tungsten 183.84		75 Re Rhenium 186.21		76 Os Osmium 190.23		77 Ir Iridium 192.22		78 Pt Platinum 195.08		79 Au Gold 196.97		80 Hg Mercury 200.59		81 Tl Thallium 204.38		82 Pb Lead 207.2		83 Bi Bismuth 208.98		84 Po Polonium (209)		85 At Astatine (210)		86 Rn Radon (222)	
87 Fr Francium (223)		88 Ra Radium (226)		89-103 Actinides		104 Rf Rutherfordium (261)		105 Db Dubnium (268)		106 Sg Seaborgium (269)		107 Bh Bohrium (270)		108 Hs Hassium (277)		109 Mt Meitnerium (278)		110 Ds Darmstadtium (281)		111 Rg Roentgenium (282)		112 Cn Copernicium (285)		113 Nh Nihonium (286)		114 Fl Flerovium (289)		115 Mc Moscovium (290)		116 Lv Livermorium (293)		117 Ts Tennessine (294)		118 Og Oganesson (294)	
57 La Lanthanum 138.91		58 Ce Cerium 140.12		59 Pr Praseodymium 140.91		60 Nd Neodymium 144.24		61 Pm Promethium (145)		62 Sm Samarium 150.36		63 Eu Europium 151.96		64 Gd Gadolinium 157.25		65 Tb Terbium 158.93		66 Dy Dysprosium 162.50		67 Ho Holmium 164.93		68 Er Erbium 167.26		69 Tm Thulium 168.93		70 Yb Ytterbium 173.05		71 Lu Lutetium 174.97							
89 Ac Actinium (227)		90 Th Thorium 232.04		91 Pa Protactinium 231.04		92 U Uranium 238.03		93 Np Neptunium (237)		94 Pu Plutonium (244)		95 Am Americium (243)		96 Cm Curium (247)		97 Bk Berkelium (247)		98 Cf Californium (251)		99 Es Einsteinium (252)		100 Fm Fermium (257)		101 Md Mendelevium (258)		102 No Nobelium (259)		103 Lr Lawrencium (260)							



Element of interest based on  
candle producer requests

## BPI Biodegradable by

**Compost** certification includes  
additional metals testing with the  
following tolerances:

Arsenic [As]	20.5 ppm
Cadmium [Cd]	10 ppm
Chromium [Cr]	530 ppm
Cobalt [Co]	75.5 ppm
Copper [Cu]	378.5 ppm
Fluorine [F]	100 ppm
Lead [Pb]	150 ppm
Mercury [Hg]	2.5 ppm
Molybdenum [Mo]	10 ppm
Nickel [Ni]	90.5 ppm
Selenium [Se]	7 ppm
Zinc [Zn]	934 ppm

# Metals analysis in paraffin wax

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3 Li Lithium 6.94																		4 Be Beryllium 9.0122																	
11 Na Sodium 22.990																		12 Mg Magnesium 24.305																	
19 K Potassium 39.098																		20 Ca Calcium 40.078																	
37 Rb Rubidium 85.468																		38 Sr Strontium 87.62																	
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87 Fr Francium (223)																																			

Atomic Number → 1  
 Name → Hydrogen  
 Symbol → H  
 Atomic Weight → 1.008

## X-Ray Fluorescence [XRF]

Spectrometry can detect

**36 elements** at  
**100 ppm threshold\***

Pros:

- Distinguishes between trace (<0.01 wt%) and not detected
- Samples analyzed as a solid

Cons:

- Sample film contains Al, Cl and Si

*\*ExxonMobil developed internal test,  
 not industry standard*



Element of interest based on  
 candle producer requests



# Metals analysis in paraffin wax

IA																		VIII A																	
1 H Hydrogen 1.008																		18 He Helium 4.0026																	
2 IIA																		13 IIIA		14 IVA		15 VA		16 VIA		17 VIIA									
3 Li Lithium 6.94		4 Be Beryllium 9.0122																		5 B Boron 10.81		6 C Carbon 12.011		7 N Nitrogen 14.007		8 O Oxygen 15.999		9 F Fluorine 18.998		10 Ne Neon 20.180					
11 Na Sodium 22.990		12 Mg Magnesium 24.305		3 IIIB		4 IVB		5 VB		6 VIB		7 VIIB		8 VIIIB		9 VIIIB		10 VIIIB		11 IB		12 IIB		13 Al Aluminium 26.982		14 Si Silicon 28.085		15 P Phosphorus 30.974		16 S Sulphur 32.06		17 Cl Chlorine 35.45		18 Ar Argon 39.948	
19 K Potassium 39.098		20 Ca Calcium 40.078		21 Sc Scandium 44.956		22 Ti Titanium 47.867		23 V Vanadium 50.942		24 Cr Chromium 51.996		25 Mn Manganese 54.938		26 Fe Iron 55.845		27 Co Cobalt 58.933		28 Ni Nickel 58.693		29 Cu Copper 63.546		30 Zn Zinc 65.38		31 Ga Gallium 69.723		32 Ge Germanium 72.630		33 As Arsenic 74.922		34 Se Selenium 78.971		35 Br Bromine 79.904		36 Kr Krypton 83.798	
37 Rb Rubidium 85.468		38 Sr Strontium 87.62		39 Y Yttrium 88.906		40 Zr Zirconium 91.224		41 Nb Niobium 92.906		42 Mo Molybdenum 95.95		43 Tc Technetium (98)		44 Ru Ruthenium 101.07		45 Rh Rhodium 102.91		46 Pd Palladium 106.42		47 Ag Silver 107.87		48 Cd Cadmium 112.41		49 In Indium 114.82		50 Sn Tin 118.71		51 Sb Antimony 121.76		52 Te Tellurium 127.60		53 I Iodine 126.90		54 Xe Xenon 131.29	
55 Cs Caesium 132.91		56 Ba Barium 137.33		57-71 Lanthanides		72 Hf Hafnium 178.49		73 Ta Tantalum 180.95		74 W Tungsten 183.84		75 Re Rhenium 186.21		76 Os Osmium 190.23		77 Ir Iridium 192.22		78 Pt Platinum 195.08		79 Au Gold 196.97		80 Hg Mercury 200.59		81 Tl Thallium 204.38		82 Pb Lead 207.2		83 Bi Bismuth 208.98		84 Po Polonium (209)		85 At Astatine (210)		86 Rn Radon (222)	
87 Fr Francium (223)		88 Ra Radium (226)		89-103 Actinides		104 Rf Rutherfordium (261)		105 Db Dubnium (268)		106 Sg Seaborgium (266)		107 Bh Bohrium (270)		108 Hs Hassium (277)		109 Mt Meitnerium (278)		110 Ds Darmstadtium (281)		111 Rg Roentgenium (282)		112 Cn Copernicium (285)		113 Nh Nihonium (286)		114 Fl Flerovium (289)		115 Mc Moscovium (290)		116 Lv Livermorium (293)		117 Ts Tennessine (294)		118 Og Oganesson (294)	
57 La Lanthanum 138.91		58 Ce Cerium 140.12		59 Pr Praseodymium 140.91		60 Nd Neodymium 144.24		61 Pm Promethium (145)		62 Sm Samarium 150.36		63 Eu Europium 151.96		64 Gd Gadolinium 157.25		65 Tb Terbium 158.93		66 Dy Dysprosium 162.50		67 Ho Holmium 164.93		68 Er Erbium 167.26		69 Tm Thulium 168.93		70 Yb Ytterbium 173.05		71 Lu Lutetium 174.97							
89 Ac Actinium 227.03		90 Th Thorium 232.04		91 Pa Protactinium 231.04		92 U Uranium 238.03		93 Np Neptunium 237.05		94 Pu Plutonium 244.06		95 Am Americium 243.06		96 Cm Curium 247.07		97 Bk Berkelium 247.07		98 Cf Californium 251.08		99 Es Einsteinium 252.08		100 Fm Fermium 257.10		101 Md Mendelevium 258.10		102 No Nobelium 259.10		103 Lr Lawrencium 262.10							



*Element of interest based on  
candle producer requests*

# Inductively Coupled Plasma Mass Spectrometry [ICP-MS]

can detect **44 elements** with  
element specific detection  
limits\*

## Advantages:

- Lower limit of detection
- **LOD ranges of 0.1 – 10 ppm**

## Disadvantages:

- Requires microwave digestion of wax

\*3P Lab developed internal test for sample digestion, ISO17294 ICP-MS

# Metals analysis in paraffin wax

1 IA 1 H Hydrogen 1.008	2 IIA 4 Be Beryllium 9.0122																18 VIIIA 2 He Helium 4.0026
3 Li Lithium 6.94												5 IIIA 13 B Boron 10.81	6 IVA 14 C Carbon 12.011	7 VA 15 N Nitrogen 14.007	8 VIA 16 O Oxygen 15.999	9 VIIA 17 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminium 26.982	14 Si Silicon 28.085	15 P Phosphorus 30.974	16 S Sulphur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Caesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89-103 Actinides	104 Rf Rutherfordium (261)	105 Db Dubnium (268)	106 Sg Seaborgium (269)	107 Bh Bohrium (270)	108 Hs Hassium (277)	109 Mt Meitnerium (278)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (282)	112 Cn Copernicium (285)	113 Nh Nihonium (286)	114 Fl Flerovium (289)	115 Mc Moscovium (290)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)
57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.05	71 Lu Lutetium 174.97			
89 Ac Actinium (227)	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (260)			

Atomic Number → 1  
Symbol ← H  
Name → Hydrogen  
Atomic Weight ← 1.008

Based on a 10 years of data, the following trace levels of metals have been detected in some paraffin waxes\*

Copper [Cu]

Iron [Fe]

Nickel [Ni]

Phosphorous [P]

Based on XRF spectroscopy Sulfur is found at trace levels in semi & fully refined waxes and anges from 0.01 – 0.06 wt%\* in low melt slack waxes have higher sulfur due to lack of hydrotreating



Element of interest based on candle producer requests

\*ExxonMobil data based on limited samples using internal test

# VOC analysis of paraffin wax

Using ASTM E1868 the mass of volatiles can be determined **but not the identity**

$$\text{VOC} = \left\{ \left[ \frac{(m_i - m_f)}{m_i} \right] - \frac{w}{100\%} \right\} \times d \times 1000 \text{ mL/L}$$

$m_i$  = initial mass [mg]

$m_f$  = final mass [mg]

$w$  = water [%]

$d$  = density [g/mL]

1

Loss on drying determined by  
**thermo-gravimetric analysis** [TGA]  
*240 minutes profile to 100 °C*

2

Water weight % determined  
by **Karl Fischer** analysis

3

**Wax density**

VOC analysis in wax varies year on  
year **ranging from 0.4 – 1.4 g/L\***  
depending on the wax

*\*ExxonMobil data based on limited samples using modified ASTM E1868*



# As we define candle wax purity

Recognize the challenges in analyzing  
waxes as we ask:



## Relevant

To wax production  
and consumer  
perception



## Tolerance

Align on an  
acceptable trace  
contamination limits



## Measurable

Define suitable  
industry standards  
for determination



# 03 Challenges

ROSEN  
CENTRE  
HOTEL

MAY  
5TH-8TH  
2025



# How do we work together?

Identifying a forum or  
working group that enables  
**effective cross-functional  
collaboration**



# How do we work together?



A

## ASTM D02.10 Properties of Petroleum Waxes & Alternative Wax-like Materials

*Membership includes Wax Producers; Additive Suppliers and End-Use Manufacturers*



B

## ASTM F15.45 Candle Products

*Development of safety and performance standards for consumer products*



C

## NCA, ECMA & ALFAVE Technical Response Committees

*Potential channels to foster technical advances and innovation in candle-making*

# Ensuring informed decision making

Representation from both raw material producers and candle manufacturers



## Breadth of perspectives

in understanding quality needs and technical capability

Set reasonable and measurable **tolerances**



## Seek external

**understanding** of science behind emerging qualities in consumer goods

Utilizing sound science and industry perspective can **enable alignment**



# Proactive response to evolving quality needs

How do we **remain aware** of potential changes to candle wax quality needs?

## Consumer Good Trade Associations

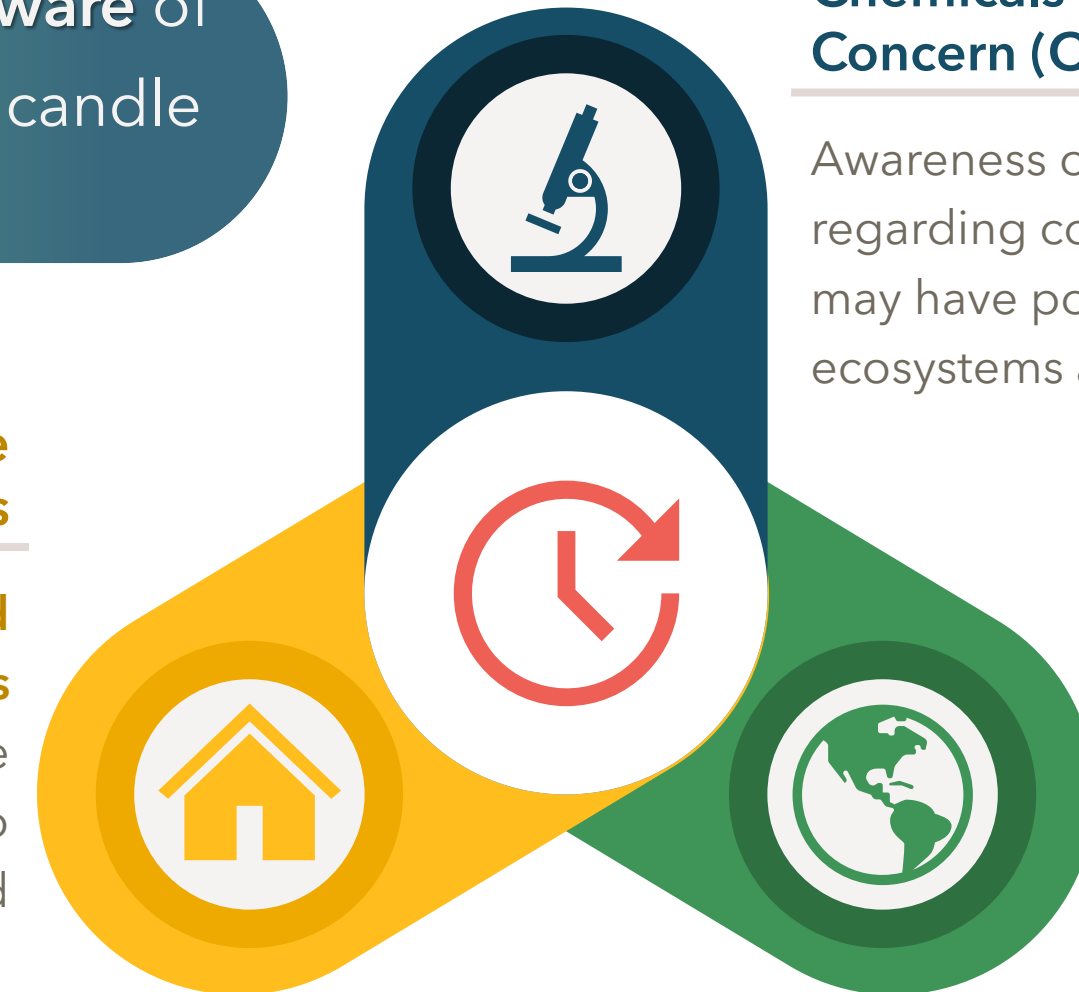
Working with **Household & Commercial Products Association** and the Candle Committee to remain informed

## Chemicals of Emerging Concern (CEC)

Awareness of **ongoing studies** regarding contaminants that may have potential impacts on ecosystems and human health

## Nongovernmental Organizations (NGOs)

Awareness to activities of advocacy groups like the **Environmental Working Group** that lead to regulation changes



# Challenges in further defining wax quality

Will require effective ways to



## Collaborate

Best forum for  
working together  
on technical front



## Align

Collectively  
determine quality  
attributes of interest



## Understand

Proactively seek  
awareness in  
emerging qualities

# 04 Collaboration



---

Join at  
**slido.com**  
**#Candles2025**

1

Participation is **voluntary**

2

Responses are **anonymous**

3

Data will be **made available**



---

Join at  
**slido.com**  
**#Candles2025**



slido



**For the rest of your life, you get to smell one candle only. What fragrance is it?**

① Start presenting to display the poll results on this slide.

slido



**Do you see value in further defining  
wax quality attributes for candles?**

① Start presenting to display the poll results on this slide.

slido



**Is food grade (FDA) quality sufficient for  
defining premium quality paraffin wax?**

① Start presenting to display the poll results on this slide.

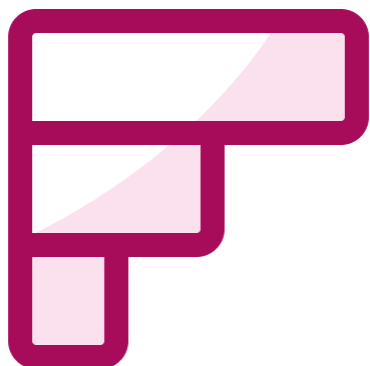
slido



**Are there certifications you would like to have or see developed for candle waxes?**

① Start presenting to display the poll results on this slide.





**What wax qualities do you most want to understand in the next year?**

① Start presenting to display the poll results on this slide.

slido



**What is the best way to work together to align our understanding of candle wax quality?**

① Start presenting to display the poll results on this slide.

# Future candle wax quality will rely on

Debating and **collectively  
aligning** on what is:

Relevant

Measurable

Emerging

# Thank You



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