Fragrance in Emulsion and Surfactant Systems

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ABSTRACT: *Fragrance is a complex system of aroma chemicals whose potential to interact with the base in formulated products is reviewed in this article, with a focus on fragrance in emulsion systems and surfactant systems.*

Much has been written on fragrance chemistry and applications, but many formulators remain unaware of the detailed mechanisms by which aroma chemicals interact with bases. With the daunting complexity of fragrances, no text will resolve all the situations that are encountered. Nevertheless, an understanding of the underlying chemistry can notably enhance the probability of success.

Fragrance is used in most personal care products. Sometimes, its purpose is simply to mask an undesirable base odor; more often it is a key sensory attribute. For some products, such as shampoo and body wash, fragrance may be the most important element in consumer appeal.

Formulators usually view fragrance as a single ingredient, a liquid in an amber bottle, often added at the end of the development process with little regard for its properties. The marketing department treats fragrance by its odor description, demographic appeal and cost. In reality, fragrance often is the most chemically complicated component of the formulation, and understanding its technical aspects is essential for the creation of an acceptable product.

Fragrance Materials

In constructing a fragrance, volatility is a key factor. The materials that are most volatile, and last the shortest time during use, are called top notes. Materials of intermediate volatility comprise the middle notes. The least volatile, longest-lasting components make the bottom notes. A pleasing blend of a few materials is called an accord. A fragrance, in its most basic form, can be constructed from a bottom accord, a middle accord and a top accord. More than 40 years ago, Jean Carles[1] provided a classic summary of fragrance construction that is still valid.

Many fragrances are created first as hydoalcoholics, for which the term *perfume* usually is used. If the fragrance is successful, line extensions are made into skin, hair and bath products. The materials that can be employed—and the balancing of the components—must be modified for aesthetic, economic and technical considerations.[2] It is easy to understand the economics. While functional fragrances frequently derive from fine fragrances, the fine fragrances have much higher price points. Expensive nuances in the fragrance usually will not be used in personal care. The aesthetic and technical aspects of translating fragrance into successful applications will occupy the remainder of this article.

Perfumers, even if they are blissfully unaware of chemistry, learn to solve many common problems through training and experience. When modifying fragrance for a specific base, some materials must be removed because of their negative impact on stability. Materials must be added to the fragrance or subtracted from it to compensate for the physical or olfactory qualities of the base. Raw material studies can identify problematic ingredients. Databases give the stability of aroma chemicals over a wide pH range or in common applications. Compendiums from aroma chemical suppliers frequently include indications of appropriate applications.

Although it is possible to solve problems without a theoretical foundation, the curious formulator will still desire a deeper understanding of why fragrances behave as they do. Fragrances embrace a widely diverse range of chemical types. Some characteristic examples of those types are shown in **Figure 1** on page 60. Aroma chemicals often contain more than one functional group, and they each contribute to the properties of the material. The literature includes numerous books[3-8] that treat the chemistry, synthesis and properties of aroma chemicals in detail.

THE CREATION OF A FRAGRANCE

The classic tale of accidental perfume creation concerned the earliest successful fragrance, Eau de Cologne. Allegedly, a perfumer in Cologne fell down some stairs while carrying a tray of various flower extracts. The resultant mixture seemed not only pleasant, but noticeably stronger than any of the individual ingredients. The effect of the whole being found to be greater than the parts, modern perfumery was born.[54]

Fragrance in Emulsion Systems

Since the 1940s, application chemists have studied the effects of fragrances in emulsion systems.[9-11] With emulsions, the obvious consequences of undesirable fragrance interactions were the thinning and breaking of emulsions, and discoloration. Odor changes taking place over time include the loss of strength and character, and the development of sour or rancid notes. An acidic note also may be detected. Surfactant systems experienced viscosity changes, solubility issues in clear systems, color changes and interactions with certified colors. Exposure to heat and UV light often exaggerated these problems.

Early investigators published many specific examples of the interaction of aroma chemicals with cosmetic bases. Pickthall[12] noticed the destabilizing effects of fragrance materials such as alcohols, phenols, acids and some esters. Hydroxycitronellal and α-terpineol are two prominent examples. Hydroxycitronellal contains two polar groups: hydroxyl and aldehydic. Its polarity enables it to compete for space on the surface of the micelle, leading to either a decrease in viscosity or a breaking of the emulsion. The α-terpineol has one hydroxyl group on a relatively rigid molecule, less disruptive than hydroxycitronellal but still

capable of destroying the balance of the emulsion. It also is possible for perfume ingredients to produce closer packing of the hydrophobes on the micelle surface, in which case emulsion stability will improve.
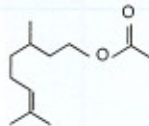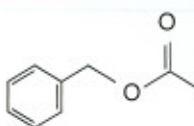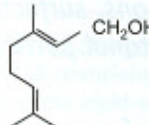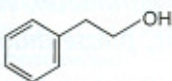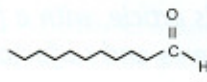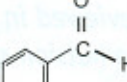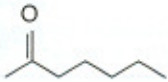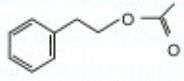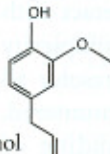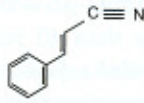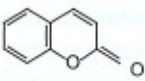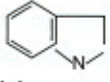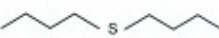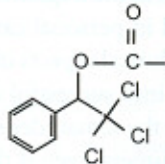

Chemical type	Examples		
Esters	Geranyl acetate (aliphatic)	Benzyl acetate (aromatic)	
Alcohols	Geraniol	Phenylethyl alcohol	
Aldehydes and ketones	Aldehyde C-11 (ylic)	Benzaldehyde	Methyl n-amyl ketone
Acetates	Phenylethyl acetate		
Phenols	Phenol	Eugenol	
Nitriles	Cinnamyl nitrile		
Lactones	Coumarin	A cyclic ester. γ or δ hydroxy acid forms 5- or 6-member ring by intramolecular esterfication.	
Heterocyclics	Indole		
Acids	CH_3COOH Acetic	C_2H_5COOH Propionic	C_3H_7COOH Butyric
Sulfur compounds	Dibutyl sulfide		
Halogen compounds	Rose crystals		

Figure 1. Some chemical types in perfumery

Karas[13] studied TEA-stearate lotions. He observed immediate separation with phenylethyl alcohol and hydroxycitronellal, breaking after five days with linalool, amylcinnamic aldehyde, terpineol and methyl ionone. Methyl anthranilate showed discoloration and slight creaming.

Wellenkamp[14] used acetals rather than the corresponding aldehydes to aid emulsion stability. He considered the acetals of phenyl acetaldehyde, phenyl propylaldehyde, cyclamen aldehyde, amyl cinnamic aldehyde, hydroxycitronellal and hydratropic aldehyde. The acetals were found to be longer-lasting, less harsh and more delicate than the aldehydes. Significantly, the acetals did not discolor soaps and creams.

In a 1980 paper,[15] Bonadeo proposed K_d to explain the effect of fragrance on emulsions. The K_d is the water/dioxane partition coefficient. The aromatic material is considered part of the oil phase, and an HLB_r is assigned, corresponding to the required HLB commonly used as a guide for nonionic emulsification. Bonadeo proposed one additional concept: the critical limit of the water phase (CLWP), which quantifies the water that can be tolerated by the emulsifier system.

Bonadeo concluded that the olfactory properties of a fragrance in a w/o or o/w emulsion are the same if the system is properly balanced; otherwise, a mixed system is formed, upsetting the fragrance distribution. He firmly places the fragrance in the oil phase, becoming a determinant in calculating the total HLB, and he concluded that the CLWP of each perfume component contributes to the limit of water that can be tolerated.

A useful method for adjusting the perfume to compensate for the effect of the substrate was presented by Saunders.[16] The smell of a fragrance out of a bottle is different from the smell after it is applied to a substrate or put in a base. What is being smelled corresponds to the headspace composition. Saunders compared the headspace proportion of each component out of the bottle and in the air over the base, deriving a ratio for each material for use as a correction factor. The perfumer's formula then is adjusted by these correction factors, resulting in a new formula. The new formula's headspace analysis in the base should be the same as the headspace of the neat oil made from the original formula. This is illustrated in **Table 1**.

Polarity

It is clear that, with the obvious exception of the interaction of functional groups, the key to understanding the behavior of aroma chemicals in diverse media is polarity. The simplest division of materials is into two groups, polar or nonpolar, but either solubility parameters (SP) or the water/octanol partition coefficient (P) is much more informative. P usually is expressed as its calculated logarithm, clogP.

Solubility parameters: Vaughan has covered the personal care applications of SP in a valuable series of articles.[17–21] The SP is a measure of all the cohesive forces in a molecule. Its consequence can easily be seen in the size of a drop. Using a uniform pipette, the weight of a drop of water, mineral oil or ethyl alcohol will be different, and the difference can be correlated directly to the SP of the materials.

In a simplified way, where aroma chemicals might partition in an emulsion system can be seen using the solubility parameter. **Table 2** shows the solubility parameter of selected fragrance materials and some common emulsion ingredients.

The most common type of emulsion is o/w, with anionic or nonionic emulsifiers. The emulsion has an oil phase of small droplets covered by emulsifier molecules, an external phase and liquid crystal structures. These different phases must be kept in mind when examining the fate of fragrance in the system.

A simplified view of the location of aroma chemicals in an emulsion is shown in **Figure 2** on page 63. Once the fragrance mixes into the emulsion, the individual components of the fragrance partition in varying

Table 2. Solubility parameters (SP) of selected fragrance materials and some common emulsion ingredients

Ingredient	SP
White mineral oil	7.09
Stearic acid	7.75
β-Pinene	8.03
Amyl acetate	8.44
Citronellal	8.83
Stearyl alcohol	8.90
Citral	9.34
Linalool	9.62
Amyl alcohol	10.84
Benzaldehyde	11.00
Eugenol	11.12
Dipropylene glycol	11.78
Phenylethyl alcohol	11.79
Benzyl alcohol	12.31
Vanillin	12.34
Propylene glycol	14.00
Water	23.40

Table 1. Analysis of headspace composition when a fragrance mixture is placed in a base (From Reference 16)

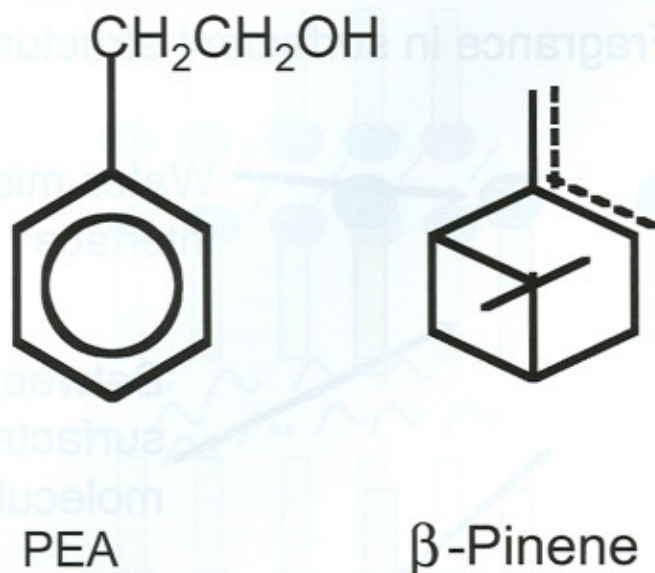| Fragrance component	a Headspace of fragrance	b Headspace over fragranced base	c a/b	d Original fragrance formula	e Adjusted fragrance formula
Limonene	31.9	15.9	2.0	2.0	4.0
Linalool	13.2	12.9	1.0	2.0	2.0
Linalyl acetate	12.3	7.7	1.6	2.0	3.3
PEA	6.2	22.6	0.3	3.5	1.1
Benzyl acetate	11.6	18.7	0.6	2.1	1.3

Figure 2. The location of aroma chemicals in an emulsion
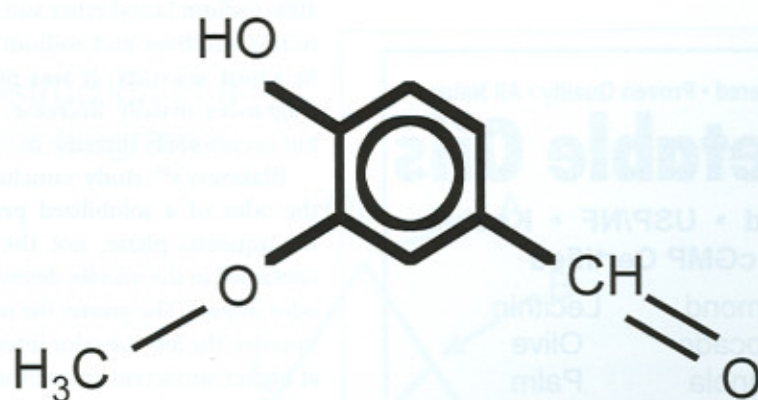
VANILLIN

SMILES: COc1cc(C=O)ccc1O

Figure 3. SMILES notation for vanillin

degrees into the different structures of the product. Pinene, with an SP under 9 and no oxygen groups, will migrate into the internal oil phase. Hydroxycitronellal, with its surface activity, can concentrate on the micelle surface; there it can displace some emulsifier, lower the viscosity or break the emulsion. Phenylethyl alcohol and vanillin, with SP greater than 11, can have substantial presence in the external aqueous phase. The amyl alcohol, with a fatty chain and hydroxyl group, can partition into the liquid crystal structure. The partitioning takes time, accounting for the aging necessary before one can accurately evaluate the effect of the base on the fragrance's olfactory performance.

Water/octanol partition coefficient: The water/octanol partition coefficient was conceived as a wet chemistry process, but the "calculated" coefficient in clogP refers to the fact that it now is more commonly determined by an algorithm of functional groups in a computer program. Because most chemical structures cannot be typed on a keyboard for computer entry, they first must be converted using programs such as the Simplified Molecular Input Line Entry System (SMILES).

In SMILES, case is important: aliphatic regions are upper case and aromatics are lower case. Hydrogen is not notated. Logically enough, a single bond is C-C and a double bond is C=C, but a triple bond requires special treatment, and is C#C. Rings are denoted by a number at the start and end: c1ccccc1Br is bromobenzene.

A more recent tool is the Graphical Input of SMILES, or GRINS. It allows

Class	Type	Log P	Value
Fragment	#1	Ether	-0.610
Fragment	#2	Aldehyde	-0.420
Fragment	#3	Alcohol or hydroxy	-0.440
Carbon		1 aliphatic isolating carbon	0.195
Carbon		6 aromatic isolating carbons	0.780
ExFragment	Hydrog	6 hydrogens on isolating carbons	1.362
ExFragment	Bonds	1 chain and 0 alicyclic (net)	-0.120
Electronic	SigRho	4 potential interactions; 1.95 used	0.787
Ortho	Ring 1	1 normal ortho interaction	-0.250
Result	**4/22+**	**All fragments measured**	**1.284**

Table 3. ClogP analysis for vanillin, calculated at *www.daylight.com/daycgi/clogp*

some ring structure to be inserted in a process similar to using a chemical drawing program. **Figure 3** shows the SMILES notation and **Table 3** shows a detailed analysis of the clogP for vanillin acquired from a Web-based calculator.[22]

The clogP of fragrances preferred in specific applications are specified in many patents. A notable example is the Procter & Gamble patent[23] protecting the Febreze[a] cleaners. Although the inventors claim cyclodextrin as the principal odor control agent, they devote more space to specifying the preferred fragrance composition. The ideal fragrance will consist of a preponderance of hydrophilic materials, especially those with clogP of 3 or less. These aroma chemicals are most compatible with aqueous systems.

Fragrance in Surfactant Systems

The study of fragrance in surfactant systems has a long history. Munden[24] published a study on the effect of

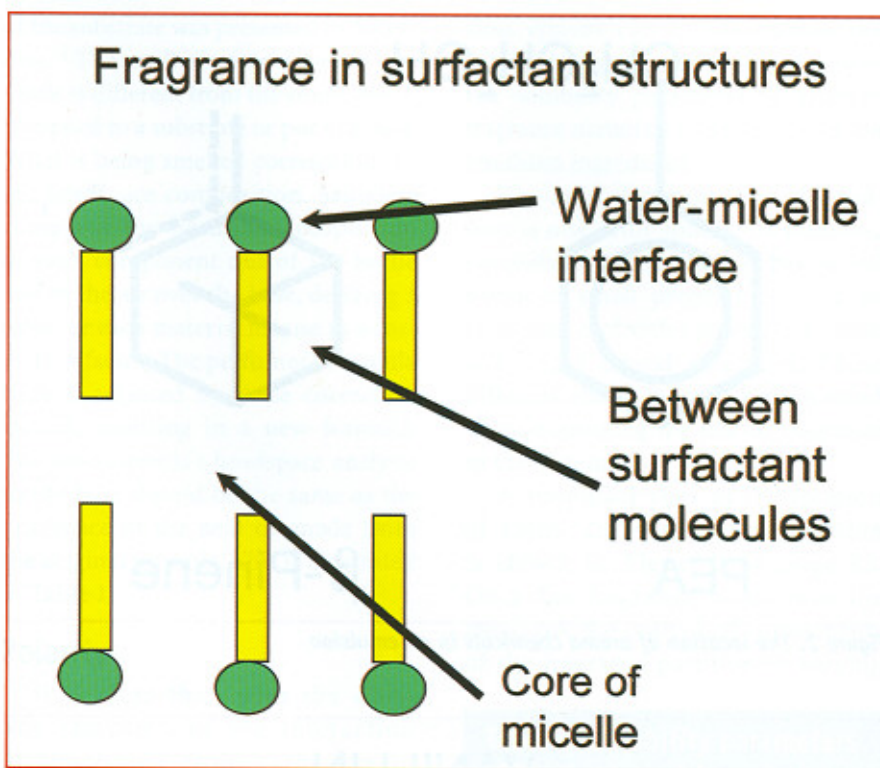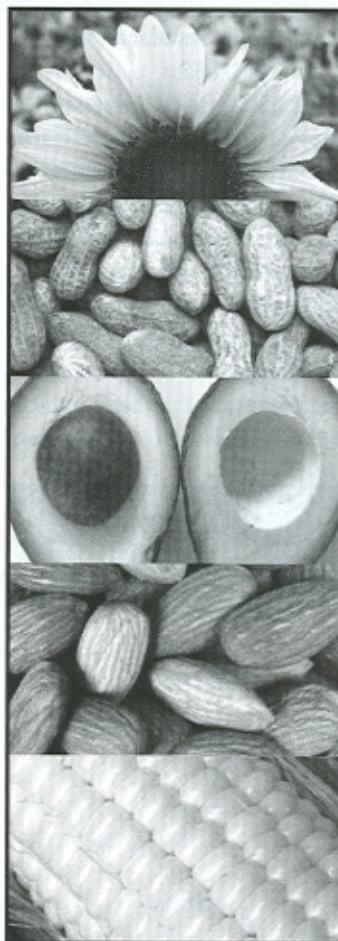[a] *Febreze is a registered trademark of Procter & Gamble.*

Figure 4. *Partitioning of aroma chemicals in a surfactant system*

fragrances on viscosity. He used a perfume consisting mainly of phenylethyl alcohol, lillial, citronellol, hexylcinnamic aldehyde, methyl dihydrojasmonate and methyl cedryl ketone. The surfactant system consisted of 10% sodium lauryl ether sulfate, some minor additives and sodium chloride to adjust viscosity. It was noted that fragrances usually decrease viscosity, but occasionally increase it.

Blakeway's[25] study concluded that the odor of a solubilized perfume in the aqueous phase, not the fraction contained in the micelle, determined the odor impact. The greater the number of micelles, the less the odor intensity, and at higher surfactant concentrations the micelles must burst, releasing aroma chemicals into the solution.

Behan and Perring[26] used headspace analysis to examine the vapor phase concentration over a shampoo system. Sodium dodecyl sulfate (SDS) was used at a range of 5–20%, but with 10% as the standard level. Aroma chemicals from 0.5% to 3% were used, with 1% the standard. The aroma chemicals studied were octan-2-one, benzyl acetate, anethole, limonene and heptan-1-ol. Several solvents/solubilizers also were considered. It was found that the solvent could profoundly influence the headspace composition of the volatile components. The perfume partitions in the SDS/water system, and increasing the surfactant

Figure 5. Liquid crystal structures in a surfactant system

Construction of a phase diagram

Figure 6. Construction of a phase diagram

alcohol or vanillin, become less soluble if the polarity of the external phase is increased by the addition of salt. Systems that overly rely on salt to build viscosity may be hard to fragrance for two reasons: the low level of surfactant and the excessive polarity of the external phase.

The partitioning of aroma chemicals in a surfactant system is shown in **Figure 4** on page 64. Some materials will migrate into the core of the micelle, some will align in the hydrophobic tails, some will be near the micelle surface and a small amount will be in the external aqueous phase. The viscosity is determined by the number, size and geometry of the micelles, in addition to any thickening that has been created in the external phase. The fragrance materials can change any of these parameters, and make the viscosity increase or decrease. The viscosity changes can be extreme and difficult to correct.

Knowledge of the structure of bases and the chemical nature of aroma chemicals allows intelligent conclusions to be drawn concerning the fate of fragrance materials in finished products, but it is not conclusive scientific proof. Research by a number of workers under the general guidance of Friberg[27–42] confirmed the nature of the interaction of fragrance chemicals with larger environments with the *a priori* observations of many formulators

It is impossible to examine every aspect of complex systems in a thorough way: the sheer number of variables make the calculations impractical. Three- or four-component systems of clearly defined composition must be used to provide manageable data. The methods used by Friberg involve titration combined with visual and polarized microscopic examination, and low angle X-ray diffraction. The X-ray diffraction measures the spacing of liquid crystal structures (**Figure 5**). The titrations yield phase diagrams that map the different structures present in the mixtures.

Changing the initial blend a number of times allows a complete analysis of the system (**Figure 6**). The line from A to B has no water content. Point A is 100% oil; B is 75% oil, 25% surfactant;

concentration reduces the quantity of aroma chemicals in the headspace.

It is known that different perfume components could concentrate in dif-

ferent areas of the micelle. Additionally, some polar materials can be present in the external phase. Materials with some water solubility, such as phenylethyl

C is 50% oil, 50% surfactant; D is 25% oil, 75% surfactant; and E is 100% surfactant. Water is titrated into the system, providing data along the lines AG, BG, CG, DG, EG, where the point G is 100% water.

To add a fourth variable, a blend of two ingredients is fixed and the titration performed as in the three-phase system. **Figure 7** has a 50:50 mixture of geraniol and olive oil in a system with steareth-10 and water. Areas of lamellar liquid crystals and microemulsions are formed.

The microemulsion regions occur where the mixture becomes clear. Liquid crystals can be observed by a cross pattern in the micelles viewed in a polarizing microscope. The spacing between lamellar liquid crystals can be measured by low-angle X-ray diffraction, revealing quantitatively the impact of the fragrance molecules on the geometry of the system.

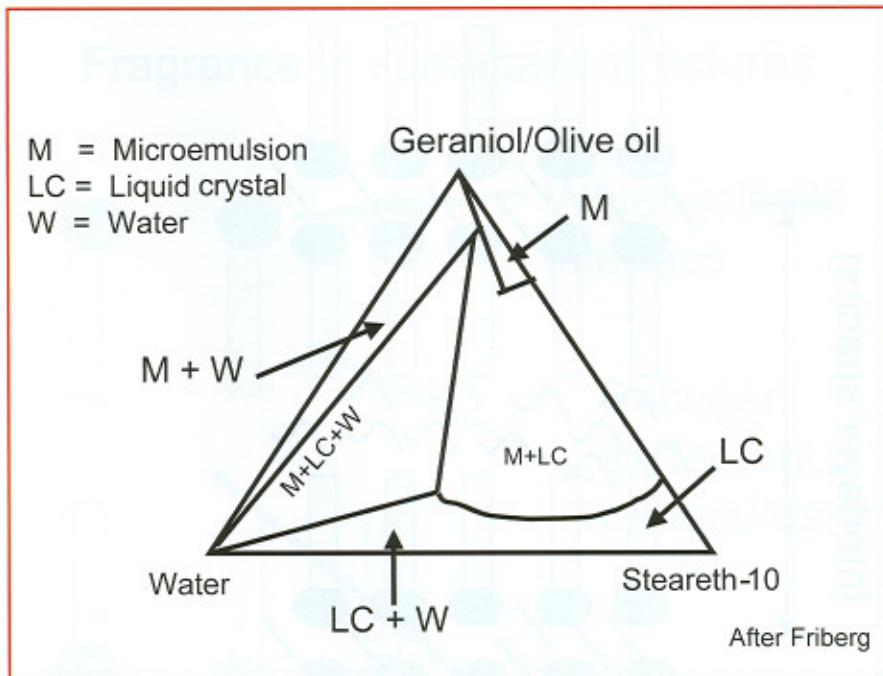The cumulative work of Friberg's group showed conclusively that different fragrance molecules occupy different areas in the surfactant or emulsion system, which certainly will affect the viscosity and stability of the system. The location of the fragrance in the surfactant structures and the interaction of the surfactant with the fragrance materials will affect the vapor pressure of the aroma chemicals in

M = Microemulsion
LC = Liquid crystal
W = Water

After Friberg

Figure 7. Phase diagram of a four-component surfactant system

the base. Thus the odor impact will be affected also.

Summary

This article has only considered a few aspects of the importance of fragrance chemistry in personal care. There are interactions with packaging; safety and regulatory issues; color interactions; problems at extreme pHs; incompatibilities with active ingredients; the subject is endless. Some additional articles[43-50] and Web sites[51-53] are included in the references to help guide interested readers, but many more exist.

The challenge to perfumers and application chemists arises from the complexity of fragrance chemistry, the varied interactions of aroma chemicals with the environment of emulsion and surfactant systems, and the added influence of external factors such as heat and light. Practical experience helps as a guide, and the brute force approach of raw material studies can produce effective fragranced products. True understanding comes with the realization that fragrances are chemicals, that bases create an environment of varied character, and that the core of fragrance chemistry is chemistry.

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References

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Note: A general reference on the topics in this article is given in Reference 54.

1. J Carles, A method of creation in perfumery, *RBD Recherches* #11 (Dec 1961), #12 (Dec 1962), #13 (Dec 1963)
2. JG Dellas and VG Lenoci, The EST principle: maintaining a fragrance accord in diverse media, *Cosm Tech* (Feb 1980)
3. M Billot and FV Wells, *Perfume Technology: Art * Science * Industry*, Chichester, UK: Ellis Horwood (1975)
4. RR Calkin and JS Jellinek, *Perfumery: Practice and Principles*, New York: Wiley Interscience (1994)
5. *Perfumes: Art Science & Technology*, PM Muller and D Lamparsky, eds, New York: Elsevier Science (1991)
6. *Chemistry and Technology of Flavors and Fragrances*, D Rowe, ed, Boca Raton: Blackwell (2005)
7. *The Chemistry of Fragrances*, CS Sell and DH Pybus, eds, Cambridge, UK: RSC (1999)
8. *Fragrance Chemistry: The Science of the Sense of Smell*, E Theimer, ed, New York: Academic Press (1982)
9. C Morel, Perfuming cosmetics and toilet preparations, *SPC* (Nov 1946)
10. W Wynne, Effect of perfume oils on emulsions, *Amer Perf & Ess Oil Rev* 381–383 (1949)
11. EG McDonough, Problems in perfuming cosmetics, *Amer Perf & Ess Oil Rev* 205–213 (1950)
12. J Pickthall, The effect of perfumery chemicals on emulsified products, *SPC* (Jan 1955)
13. SA Karas, The effect of some aromatic chemicals and essential oils upon the stability of cosmetic emulsions, *J Soc Cosm Chem* 1 (1949)
14. CK Wellencamp, Fragrance stability of cosmetics with especial reference to acetals, *Pro Sci Sec TGA 12 20–22* (1949)
15. I Bonadeo et al, Hydrophilic properties of aromatics, *Int J Cos Sci* 2 215–229 (1980)
16. HC Saunders, An approach to fitting a perfume to the polarity of its substrate, *Cosmet Toil* 88(11) 31–34 (1973)
17. CD Vaughan, Using solubility parameters in cosmetic formulation, *J Soc Cos Chem* 16(5) 319–333 (1985)
18. CD Vaughan, Solubility effects in product, packaging, penetration and preservation, *Cosmet Toil* 103(10) 47–69 (1988)
19. CD Vaughan and D Rice, Predicting O/W emulsion stability by the "required HLB equation," *J Disp Sci & Tech* 11(1) 83–91 (1990)
20. CD Vaughan, The solubility parameter: What is it? *Cosmet Toil* 106(11) 69–72 (1991)
21. CD Vaughan, Solubility parameters for characterizing new raw materials, *Cosmet Toil* 108(9) 57–62 (1993)
22. www.daylight.com/daycgi/clogp
23. US Pat 5 783 544, Composition for reducing malodor impression on inanimate surfaces, assigned to The Procter & Gamble Company (1998)
24. DR Munden, Effect of perfumes on the viscosity of surfactant systems, *Cosmet Toil* 103(11) 65 (1988)
25. JM Blakeway et al, Studies in perfume solubilization, *Int J Cosmet Sci* 1 1–15 (1979)
26. JM Behan and KD Perring, Perfume interactions with sodium dodecyl sulphate solutions, *Int J Cosmet Sci* 9 261–268 (1987)
27. SE Friberg et al, The location of vanillin in a food emulsion system, in *Physical Chemistry of Flavors*, ACS Sym Series #177, SL Holt, ed, Washington, DC: American Chemical Society (1982)
28. SE Friberg and S Vona, Fragrance microemulsons, triethylcitrate, water, sodium dodecylsulfate and pentanol, *Soap Cosmet Chem Spec* 32–40 (Aug 1994)
29. SE Friberg et al, Vapor pressure of phenylethyl alcohol in the system with water and polyoxyethylene-4 lauryl ether (Brij30), *Progr Colloid Polym Sci* 101 18–22 (1996)
30. Yang et al, The phase behavior of polyoxyethylene-10 stearyl ether/geraniol/olive oil/H_2O system and preliminary evaluation of fragrance evaporation, *Int J Cosmet Sci* 18 43–56 (1996)
31. SE Friberg et al, Vapour pressure of a fragrance ingredient during evaporation in a simple emulsion, *Int J Cosmet Sci* 19(6) 259 (1997)
32. SE Friberg, Vapor pressure of some fragrance ingredients in emulsion and microemulsion formulations, *Int J Cosmet Sci* 19 75–86 (1997)
33. SE Friberg et al, Vapor pressure of phenylethyl acetate in the system with water and polyoxyethylene-4 lauryl ether, *J Molecular Liquids* 72 31–53 (1997)
34. SE Friberg et al, Vapor pressure of phenylethyl alcohol in an aqueous hydrotrope solution, *Colloids Surf A* 127 233–239 (1997)
35. SA Vona Jr et al, Location of fragrance molecules within lamellar liquid crystals, *Colloids Surf A* 137 79–89 (1998)
36. SE Friberg and L Fei, Vapor pressure of phenylethyl alcohol and phenylethyl acetate in aqueous solutions of sodium xylene sulfonate and polyvinylpyrrolidone, *Progr Colloid Polym Sci* 109 93–100 (1998)
37. SE Friberg et al, Vapour pressures of phenethyl alcohol and limonene in systems with water and laureth 4, *Int J Cosmet Sci* 20(6) 355 (1998)
38. SE Friberg, Fragrance compounds and amphiphilic association structures, *Adv Colloid Interface Sci* 75 181–214 (1998)
39. SE Friberg et al, Stability factors and vapor pressures in a model fragrance emulsion system, *J Cosmet Sci* 50 203–219 (1999)
40. SE Friberg et al, Vapor pressures and amphiphilic association structures, *Colloids & Surfaces* 159 17–30 (1999)
41. SE Friberg et al, Phase diagram and emulsion stability of surfactant-fragrance systems, *Int J Cosmet Sci* 22(2) 105–119 (2000)
42. SE Friberg et al, Change of amphiphilic association structures during evaporation from emulsions in surfactant-fragrance-water systems, *Int J Cosmet Sci* 22(3) 181–199 (2000)
43. A Seldner, Fragrance: Basics for the formulating chemist, *Cosm Tech* (Feb 1980)
44. SJ Herman, Fragrance chemistry, *Chem Tech* (Aug 1992)
45. SJ Herman, Fragrancing emulsions, *Cosmet Toil* 109(8) 71–75 (1994)
46. A Baydar et al, Behavior of fragrance on skin, *Cosmet Toil* 111(2) 49–57 (1996)
47. R Schueller and P Romanowski, Common "scents": Fragrance in personal care products, *Cosmet Toil* 111(2) 59–66 (1996)
48. BD Mookherjee et al, A novel technology to study the emission of fragrance from the skin, *Perfum Flav* 23(1) 7–11 (1998)
49. F Buccellato and C Buccellato, What every formulator needs to know about fragrance, *Cosmet Toil* 116(11) 49–54 (2001)
50. JS Jellinek, Implicit olfaction: Effect of use of fragrance in functional products, *Cosmet Toil* 118(6) 47–63 (2003)
51. www.rifm.org (Accessed Feb 8, 2006)
52. www.ifraorg.org (Accessed Feb 8, 2006)
53. www.leffingwell.com (Accessed Feb 8, 2006)
54. SJ Herman, *Fragrance Applications: A Survival Guide*, Carol Stream, Illinois: Allured Publishing (2002)   C&T

Personal Care Ingredients Asia: Innovating Answers

Personal Care Ingredients Asia's (PCIA) showcase of more than 5,000 raw materials and ingredients, married with the information and advice needed to formulate products, was a key focal point at the conference and exhibition, held March 7–9, 2006, in Seoul, Korea. More than 200 international manufacturers and suppliers of raw materials and ingredients participated in this year's exhibition, representing all the key areas of the market and offering innovations to shape the present and the future.

Color cosmetic formulations incorporating actives for beyond-color effects were launched by Sederma. Actives stirred the PCIA scene as several companies offered antiaging answers. A novel active from prickly pear was presented by Mibelle to hydrate and protect the skin from the environment. Cognis

highlighted its *Vigna aconitifolia* seed botanical active with effectiveness reportedly similar to retinol. Additionally, Vincience rolled out numerous peptide, botanical, biotech and marine ingredients for slimming, anti-stress/antiaging, skin lightening, anti-itch/anti-irritant and other skin care effects.

In skin care, "soft and mild" was the focus of Desert Whale Jojoba Company's natural exfoliants, based on jojoba esters "spheres" technology. Wacker showcased novel cyclodextrin complexes and silicone elastomer gels for skin care, and alkyl-modified silicone waxes for the formulation of shampoos and conditioners. Cognis

also added a multifunctional wax dispersion to the conditioning hair care offerings, among others.

Beyond education on the exhibition show floor, PCIA offered attendees a scientific program on key industry areas: hair care, active ingredients, antiaging, skin whitening and protection, delivery systems and novel formulating.

PCIA welcomed attendees with more than 200 exhibits and a three-day scientific conference of more than 30 paper presentations.

Locating Aroma Chemicals in a W/O Emulsion

Editor's note: Following is a corrected version of Figure 2 appearing on page 63 from Steve Herman's article in the April issue. C&T regrets the error.
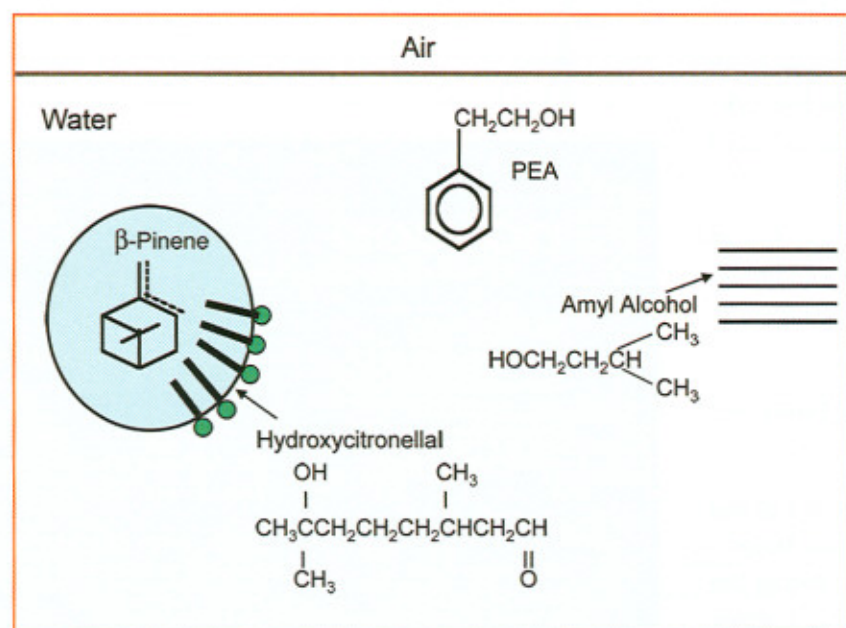

Figure 2. The location of aroma chemicals in an emulsion

A simplified view of the location of aroma chemicals in an emulsion is shown in **Figure 2**. Once the fragrance mixes into the emulsion, the individual components of the fragrance partition in varying degrees into the different structures of the product. Pinene, with an SP under 9 and no oxygen groups, will migrate into the internal oil phase. Hydroxcitronellal, with its surface activity, can concentrate on the micelle surface; there it can displace some emulsifier, lower the viscosity or break the emulsion. Phenylethyl alcohol and vanillin, with SP greater than 11, can have substantial presence in the external aqueous phase. The amyl alcohol, with a fatty chain and hydroxyl group, can partition into the liquid crystal structure. The partitioning takes time, accounting for the aging necessary before one can accurately evaluate the effect of the base on the fragrance's olfactory performance.