alcohol sulfation and carbon-carbon double bond sulfonation may compete, with most of the reaction product resulting from sulfation, although the nature of the sulfonated by-products is generally not well understood (see, e.g., U.S. Pat. No. 5,446,188). Because of the competing side reactions, unsaturated alcohols are usually avoided when the goal is to make an alcohol sulfate or ether sulfate.

In sum, despite the known value of longer-chain fatty alcohols and shorter-chain saturated fatty alcohols for making ethoxylates, sulfates, and ether sulfates for use as surfactants, it is less clear what value the surfactants would have if they were made using shorter-chain unsaturated (e.g., C_{10}-C_{12}) fatty alcohols. The availability of undecylenic acid and undecylenic alcohol as feedstocks invites further investigation.

SUMMARY

In one ~~aspect~~embodiment, the present disclosure relates to a surfactant composition comprising water and 1 to 99 wt.% of a surfactant. The surfactant comprises an alkoxylate, a sulfate or an ether sulfate of a C_{10}-C_{12} monounsaturated alcohol. In particular embodiments, the alkoxylate, sulfate, or ether sulfate derives from readily available undecylenic acid or undecylenic alcohol. In other embodiments, the surfactant comprises 40 to 60 wt.% of a monounsaturated C_{10}-C_{12} primary alcohol sulfate and 40 to 60 wt.% of a secondary hydroxyalkyl C_{10}-C_{12} primary alcohol sulfate. In an aspect, there is provided a composition comprising water and 1 to 99 wt.% of a surfactant, wherein the surfactant comprises an ether sulfate of the formula: CH_2=CH-$(CH_2)_9$-O-$(EO)_n$-SO_4^- M^+, wherein n is the average number of EO units and has a value from 1 to 5, and M is Na, K, Li, or NH_4. In another aspect, there is provided a composition comprising water and 1 to 99 wt.% of a surfactant comprising sulfates of undecylenic alcohol, wherein the surfactant comprises: (a) 40 to 60 wt.% of a monounsaturated C_{11} primary alcohol sulfate; and (b) 40 to 60 wt.% of a secondary hydroxyalkyl C_{11} primary alcohol sulfate.

We found that alkoxylate, sulfate, and ether sulfate surfactants made from C_{10}-C_{12} monounsaturated alcohols offer unexpected advantages. Compared with their saturated analogs, the monounsaturated alkoxylates, sulfates, and ether sulfates are less irritating, making them valuable for personal care, laundry, cleaners, and other

household applications. Additional advantages are apparent from microscopy studies, which indicate that the monounsaturated alkoxylates, sulfates, and ether sulfates have favorable phase behavior over a wide range of actives levels. This enables formulation of products with greater compaction, allowing formulators to ship more product and less water in a given container. When combined with cationic surfactants, the alkoxylates, sulfates and ether sulfates exhibit considerable synergy, and they have improved solubility compared with their saturated analogs.

The surfactants will be useful in many applications and industries, including personal care, laundry and cleaning, emulsion polymerization, agricultural products, oilfield applications, and specialty foams.

In another aspect, there is provided a water-soluble herbicide or an agricultural dispersant comprising the compositions as disclosed above.

In another aspect, there is provided a hard-surface cleaner or a glass cleaner comprising the compositions as disclosed above.

~~In another aspect, there is provided a glass cleaner comprising the composition as disclosed above.~~

~~In another aspect, there is provided an agricultural dispersant comprising the composition as disclosed above.~~

In another aspect, there is provided a ~~synergistic surfactant~~ blend comprising a cationic surfactant and the compositions as disclosed above.

In another aspect, there is provided a process which comprises reacting undecylenic alcohol ~~a composition comprising a monounsaturated C_{10}-C_{12} alcohol~~ with ~~an alkoxylating agent, a sulfating agent, or an alkoxylating agent followed by a sulfating agent to make, respectively, an alkoxylate, a sulfate, or an ether sulfate.~~

~~In another aspect, there is provided a process for making an internally monounsaturated C_{10}-C_{12} alcohol sulfate or ether sulfate, the process comprising reacting a terminally monounsaturated C_{10}-C_{12} alcohol or alkoxylate with~~ sulfur trioxide in a falling-film reactor, followed by neutralization to produce a surfactant comprising: (a) 40 to 60 wt.% of a monounsaturated C_{11} primary alcohol sulfate; and (b) 40 to 60 wt.% of a secondary hydroxyalkyl C_{11} primary alcohol sulfate.

We claim:

1. A composition comprising water and 1 to 99 wt.% of a surfactant, wherein the surfactant comprises an ether sulfate of the formula:

$$CH_2=CH-(CH_2)_9-O-(EO)_n-SO_4^- M^+$$

wherein n is the average number of EO units and has a value from 1 to 5, and M is Na, K, Li, or NH_4.

2. The composition of claim **1** wherein M is Na or NH_4.

3. The composition of claim **1** wherein M is Na and n is 1 or 3.

4. The composition of claim **1** wherein M is NH_4 and n is 1.

5. A composition comprising water and 1 to 99 wt.% of a surfactant comprising sulfates of undecylenic alcohol, wherein the surfactant comprises:

(a) 40 to 60 wt.% of a monounsaturated C_{11} primary alcohol sulfate; and

(b) 40 to 60 wt.% of a secondary hydroxyalkyl C_{11} primary alcohol sulfate.

6. The composition of claim **5** comprising 2 to 98 wt.% of the surfactant.

7. The composition of claim **5** wherein the surfactant further comprises 0.1 to 20 wt.% of sulfonated products.

8. The composition of claim **5** made by sulfating undecylenic alcohol with sulfur trioxide in a falling-film reactor, followed by neutralization.

9. A water-soluble herbicide or an agricultural dispersant comprising the composition of claim **1** or claim **5**.

10. A hard-surface cleaner or a glass cleaner comprising the composition of claim **1** or claim **5**.

11. A blend comprising a cationic surfactant and the composition of claim **1** or claim **5**.

12. A process which comprises reacting undecylenic alcohol with sulfur trioxide in a falling-film reactor, followed by neutralization to produce a surfactant comprising:

(a) 40 to 60 wt.% of a monounsaturated C_{11} primary alcohol sulfate; and

(b) 40 to 60 wt.% of a secondary hydroxyalkyl C_{11} primary alcohol sulfate.

We claim:

1. A surfactant composition comprising water and 1 to 99 wt.% of a surfactant comprising an alkoxylate, a sulfate, or an ether sulfate of a C_{10}-C_{12} monounsaturated alcohol.

2. The composition of claim **1** comprising 2 to 98 wt.% of the surfactant.

3. The composition of claim **1** wherein the surfactant comprises:

(a) 40 to 60 wt.% of a monounsaturated C_{10}-C_{12} primary alcohol sulfate; and

(b) 40 to 60 wt.% of a secondary hydroxyalkyl C_{10}-C_{12} primary alcohol sulfate.

4. The composition of claim **3** wherein the surfactant further comprises 0.1 to 20 wt.% of sulfonated products.

5. The composition of claim **3** wherein (a) and (b) derive from a C_{11} monounsaturated alcohol.

6. The composition of claim **3** wherein (a) and (b) derive from undecylenic alcohol.

7. The composition of claim **3** wherein (a) has the structure:

$$R\text{-}O\text{-}SO_3X$$

wherein R is a linear or branched C_{10}-C_{12} monounsaturated hydrocarbyl group, and X is a mono- or divalent cation or an ammonium or substituted ammonium cation.

8. The composition of claim **3** wherein (b) has the structure:

$$CH_3\text{-}(CH_2)_y\text{-}CHOH\text{-}(CH_2)_z\text{-}O\text{-}SO_3X$$

wherein y= 0 to 8, z= 0 to 8, y+z = 8 to 10, and X is a mono- or divalent cation or an ammonium or substituted ammonium cation.

9. The composition of claim **8** wherein y+z = 9.

10. The composition of claim **3** made by sulfating a monounsaturated C_{10}-C_{12} alcohol with sulfur trioxide in a falling-film reactor, followed by neutralization.

11. The composition of claim **1** wherein the surfactant comprises an ether sulfate of undecylenic alcohol.

12. The composition of claim **1** wherein the surfactant comprises an ether sulfate of the formula:

$CH_2=CH-(CH_2)_m-O-(EO)_n-SO_4^-M^+$

wherein m=8-10, n is the average number of EO units and has a value from 0.5 to 60, and M is Na, K, Li, or NH_4.

13. The composition of claim **12** wherein n has a value from 1 to 20.

14. The composition of claim **12** wherein n has a value from 1 to 5.

15. The composition of claim **1** wherein the alkoxylate is an ethoxylate having an average of 0 to 60 oxyethylene units.

16. The composition of claim **15** wherein the ethoxylate has an average of 1 to 10 oxyethylene units.

17. The composition of claim **1** wherein the monounsaturated alcohol is selected from the group consisting of 9-decen-1-ol, 8-decen-1-ol, 7-decen-1-ol, 6-decen-1-ol, 5-decen-1-ol, 4-decen-1-ol, 3-decen-1-ol, 10-undecen-1-ol, 9-undecen-1-ol, 8-undecen-1-ol, 7-undecen-1-ol, 6-undecen-1-ol, 5-undecen-1-ol, 4-undecen-1-ol, 3-undecen-1-ol, 11-dodecen-1-ol, 10-dodecen-1-ol, 9-dodecen-1-ol, 8-dodecen-1-ol, 7-dodecen-1-ol, 6-dodecen-1-ol, 5-dodecen-1-ol, 4-dodecen-1-ol, and 3-dodecen-1-ol.

18. The composition of claim **1** wherein a zein test indicates that the composition is less irritating when compared with a similar composition prepared using a saturated analog of the alkoxylate, sulfate, or ether sulfate.

19. The composition of claim **1** having an isotropic clear phase over a broader % actives range compared with that of a similar composition prepared using a saturated analog of the alkoxylate, sulfate, or ether sulfate.

20. The composition of claim **1** having an isotropic clear phase at any actives level up to 60 wt.% actives.

21. A water-soluble herbicide comprising the composition of claim **1**.

22. A hard-surface cleaner comprising the composition of claim **1**.

23. A glass cleaner comprising the composition of claim **1**.

24. An agricultural dispersant comprising the composition of claim **1**.

25. A synergistic surfactant blend comprising a cationic surfactant and the composition of claim **1**.

26. The blend of claim **25** that exhibits an improved solubility profile when compared with that of a similar blend comprising a saturated analog of the alkoxylate, sulfate, or ether sulfate.

27. The blend of claim **25** wherein the degree of synergy in the blend, as measured by comparing calculated versus actual values for interfacial surface tension (IFT), exceeds that of a similar blend comprising a saturated analog of the alkoxylate, sulfate, or ether sulfate.

28. A process which comprises reacting a composition comprising a monounsaturated C_{10}-C_{12} alcohol with an alkoxylating agent, a sulfating agent, or an alkoxylating agent followed by a sulfating agent to make, respectively, an alkoxylate, a sulfate, or an ether sulfate.

29. The process of claim **28** wherein the monounsaturated C_{10}-C_{12} alcohol or alkoxylate is reacted with sulfur trioxide in a falling-film reactor, followed by neutralization.

30. A process for making an internally monounsaturated C_{10}-C_{12} alcohol sulfate or ether sulfate, the process comprising reacting a terminally monounsaturated C_{10}-C_{12} alcohol or alkoxylate with sulfur trioxide in a falling-film reactor, followed by neutralization.