some applications, however, it may be desirable to retain a larger proportion of the solder flux at 250°C or higher temperatures than is normally the case with a solvent-based flux. Manufacturers would favor added flexibility from fluxes that could tolerate higher processing temperatures.

Desirably, tacky solder fluxes can also wet metal surfaces effectively and remove oxide impurities.

The industry would benefit from the availability of improved tacky solder fluxes. A desirable tacky solder flux would be non-aqueous, cost-effective, have good wettability capability, and have a rheological profile suitable for use in a high-speed, pick-and-place manufacturing process. Valuable fluxes could be tailored to achieve a desirable evaporation profile. Ideally, the formulation would be easy to formulate using readily available materials.

SUMMARY OF THE INVENTION

In some aspects, the invention relates to non-aqueous solder flux compositions. In one aspect, the composition comprises: (a) 40 to 60 wt.% of an alkylbenzene sulfonic acid; and (b) 40 to 60 wt.% of an alkanolamide, an ethoxylated alkanolamide, an alkanolamine, or an ethoxylated amine, where the wt.% amounts are based on the combined amounts of (a) and (b).

In one aspect, there is provided a composition comprising (a) 45 to 50 wt.% of an alkylbenzene sulfonic acid; and (b) 50 to 55 wt.% of an alkanolamine, or an ethoxylated amine having an average of 2 to 4 ethylene oxide (EO) units; said wt.% amounts based on the combined amounts of (a) and (b); wherein the composition is a non-aqueous solder flux.

In another aspect, the non-aqueous solder flux composition comprises: (a) 40 to 60 wt.% of an acidic phosphate ester; and (b) 40 to 60 wt.% of an alkanolamide, an ethoxylated alkanolamide, an alkanolamine, or an ethoxylated amine, where the wt.% amounts are based on the combined amounts of (a) and (b).

In one aspect, there is provided a composition comprising (a) 45 to 50 wt.% of an acidic phosphate ester; and (b) 50 to 55 wt.% of an alkanolamine, or an ethoxylated amine

having an average of 2 to 4 EO units; said wt.% amounts based on the combined amounts of (a) and (b); wherein the composition is a non-aqueous solder flux.

In yet another aspect, the non-aqueous solder flux composition consists essentially of: (a) 40 to 60 wt.% of an alkylbenzene sulfonic acid or an acidic phosphate ester; and (b) 40 to 60 wt.% of an alkanolamide, an ethoxylated alkanolamide, an alkanolamine, or an ethoxylated amine.

In a further aspect, there is provided a composition consisting essentially of (a) 45 to 50 wt.% of an alkylbenzene sulfonic acid or an acidic phosphate ester; and (b) 50 to 55 wt.% of an alkanolamine, or an ethoxylated amine having an average of 2 to 4 EO units; said wt.% amounts based on the combined amounts of (a) and (b); wherein the composition is a non-aqueous solder flux.

In other aspects, the compositions have little or no “sag,” demonstrated by recovery of at least 90% of their zero-shear viscosities through multiple cycles of shear thinning and relaxation.

In some aspects, the solder flux composition has good wettability on metal coupons in an industry-standard wetting balance test when compared with a control flux. In some aspects, the flux compositions have improved ability to remove oxidation from an oxidized metal surface.

In one aspect, there is provided a mixture comprising solder and the composition described herein.

In another aspect, there is provided a method of making a solder flux composition, the method comprising: (a) combining ~~40~~ 45 to ~~60~~ 50 wt.% of an alkylbenzene sulfonic acid or an acidic phosphate ester with ~~40~~ 50 to ~~60~~ 55 wt.% of ~~an alkanolamide, an ethoxylated alkanolamide,~~ an alkanolamine, or an ethoxylated amine having an average of 2 to 4 EO units, and (b) mixing until the composition is substantially homogeneous. The invention includes methods of making solder flux compositions and methods of using the inventive compositions as components of tacky solder fluxes.

We surprisingly found that solder flux compositions having excellent wettability, oxide-removal capability, and rheological characteristics for high-speed, pick-and-place manufacturing processes can be made from a simple combination of two components thereby avoiding the need for solvents, polymeric thickeners, and other components of traditional tacky solder fluxes.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plot from a dynamic shear rheometry (DSR) experiment measuring viscosity (Pa•s) versus shear rate (s^{-1}) for a 50:50 (wt/wt) blend of BIO-SOFT® S-126 (dodecylbenzene sulfonic acid) and TOXIMUL® TA-2 (tallowamine 2EO ethoxylate).

Fig. 2 is a plot from a similar DSR experiment for ZELEC® NK, an alcohol phosphate ester neutralized with an equivalent of diethanolamine.

Fig. 3 is a plot from a similar DSR experiment for a 50:50 blend of ZELEC® UN, an acidic alcohol phosphate ester, and TOXIMUL® TA-2.

Fig. 4 is a plot from a similar DSR experiment for a 50:50 blend of CEDEPHOS® FA-600, an acidic alcohol phosphate ester, and TOXIMUL® TA-2.

Fig. 5 is a plot from a similar DSR for a 50:50 blend of CEDEPHOS® FA-600 and NINOL® 1301 (cocamide PEG-6).

Fig. 6 is a comparative plot from a DSR experiment measuring viscosity versus shear rate for a 60:40 blend of BIO-SOFT® S-126 and TOXIMUL® TA-2.

Fig. 7 is a comparative plot from a similar DSR experiment for a 50:50 blend of BIO-SOFT® S-126 and TOXIMUL® TA-5 (tallowamine 5EO ethoxylate).

Fig. 8 is a comparative plot from a similar DSR experiment for a 50:50 blend of BIO-SOFT® S-126 and TOXIMUL® TA-15 (tallowamine 15EO ethoxylate).

We claim:

1. A composition comprising:

(a) ~~40~~ 45 to ~~60~~ 50 wt.% of an alkylbenzene sulfonic acid; and

(b) ~~40~~ 50 to ~~60~~ 55 wt.% of ~~an alkanolamide, an ethoxylated alkanolamide,~~ an alkanolamine, or an ethoxylated amine having an average of 2 to 4 ethylene oxide (EO) units;

said wt.% amounts based on the combined amounts of (a) and (b);

wherein the composition is a non-aqueous solder flux.

2. The composition of claim **1** wherein the alkyl group of the alkylbenzene sulfonic acid is a linear or branched C_1-C_{18} alkyl group.

3. The composition of claim **1** wherein the alkylbenzene sulfonic acid is dodecylbenzene sulfonic acid.

4. The composition of claim **1** wherein the composition comprises the alkylbenzene sulfonic acid and an ethoxylated amine having an average of 2 to 4 EO units.

5. The composition of claim **4** wherein the ethoxylated amine is a cocamine ethoxylate, a lauramine ethoxylate, or a tallowamine ethoxylate, each having an average of 2 to ~~5~~ 4 EO units.

6. The composition of claim **4** wherein the alkylbenzene sulfonic acid is dodecylbenzene sulfonic acid and the ethoxylated amine is a tallowamine ethoxylate having an average of 2 to ~~5~~ 4 EO units.

~~**7.** The composition of claim **1** comprising 45 to 55 wt.% of the alkylbenzene sulfonic acid and 45 to 55 wt.% of an ethoxylated amine.~~

~~**8.** The composition of claim **1** wherein the alkanolamide is cocamide MEA, cocamide DEA, lauramide MEA, lauramide DEA, oleamide MEA, oleamide DEA, cocamide MIPA, lauramide MIPA, or oleamide MIPA.~~

~~**9.** The composition of claim **1** wherein the ethoxylated alkanolamide is a PEG cocamide or a PEG lauramide, either having an average of 4 to 8 EO units.~~

~~**10**~~**7.** The composition of claim **1** wherein the alkanolamine is diethanolamine.

~~**11**~~**8.** The composition of claim **1** wherein the composition is essentially free of fatty acid salts.

~~12~~9. The composition of claim **1** wherein the composition has good wettability on metal coupons in a wetting balance test as described herein compared with that of a control flux as evidenced by a wetting force that is generated within 1 second from the start of the test, and is sustained for at least 10 seconds, of greater than 0.2 mN/mm.

~~13~~10. The composition of claim **1**, that upon dilution with water, has a pH within the range of 1.0 to 6.0.

~~14~~11. A mixture comprising solder and the composition of claim **1**.

~~15~~12. A composition comprising:

(a) ~~40~~ 45 to ~~60~~ 50 wt.% of an acidic phosphate ester; and

(b) ~~40~~ 50 to ~~60~~ 55 wt.% of ~~an alkanolamide, an ethoxylated alkanolamide,~~ an alkanolamine, or an ethoxylated amine having an average of 2 to 4 EO units;

said wt.% amounts based on the combined amounts of (a) and (b);

wherein the composition is a non-aqueous solder flux.

~~16~~13. The composition of claim ~~15~~ 12 wherein the acidic phosphate ester is a phosphate ester of an ethoxylated isodecyl alcohol, an ethoxylated tridecyl alcohol, an ethoxylated tristyrylphenol, or an ethoxylated nonylphenol.

~~17~~14. The composition of claim ~~15~~ 12 comprising the acidic phosphate ester and ~~an alkanolamide, an ethoxylated alkanolamide, or~~ an ethoxylated amine.

~~18~~15. The composition of claim ~~17~~ 14 wherein the ethoxylated amine is a cocamine ethoxylate, a lauramine ethoxylate, or a tallowamine ethoxylate, each having an average of 2 to ~~5~~ 4 EO units.

~~19. The composition of claim 17 wherein the alkanolamide is cocamide MEA, cocamide DEA, lauramide MEA, lauramide DEA, oleamide MEA, oleamide DEA, cocamide MIPA, lauramide MIPA, or oleamide MIPA.~~

~~20. The composition of claim 17 wherein the ethoxylated alkanolamide is a PEG cocamide or a PEG lauramide, either having an average of 4 to 8 EO units.~~

~~21~~16. The composition of claim ~~15~~ 12 comprising the acidic phosphate ester and an alkanolamine.

~~22~~17. The composition of claim ~~21~~ 16 wherein the alkanolamine is diethanolamine.

~~23~~18. The composition of claim ~~15~~ 12 wherein the composition has good wettability on metal coupons in a wetting balance test as described herein compared with that of a control flux as evidenced by a wetting force that is generated within 1 second from the start of the test, and is sustained for at least 10 seconds, of greater than 0.2 mN/mm.

~~24~~19. The composition of claim ~~15~~12, that upon dilution with water, has a pH within the range of 1.0 to 6.0.

20. The composition of claim 1 or claim 12, wherein the ethoxylated amine has an average of 2 to 3 EO units.

21. The composition of claim 1 or claim 12, wherein the ethoxylated amine has an average of 2 EO units.

~~25~~22. A mixture comprising solder and the composition of claim ~~15~~12.

~~26~~23. A composition consisting essentially of:

(a) ~~40~~ 45 to ~~60~~ 50 wt.% of an alkylbenzene sulfonic acid or an acidic phosphate ester; and

(b) ~~40~~ 50 to ~~60~~ 55 wt.% of ~~an alkanolamide, an ethoxylated alkanolamide,~~ an alkanolamine, or an ethoxylated amine having an average of 2 to 4 EO units;

said wt.% amounts based on the combined amounts of (a) and (b);

wherein the composition is a non-aqueous solder flux.

~~27~~24. The composition of claim ~~26~~ 23 wherein the alkyl group of the alkylbenzene sulfonic acid is a linear or branched C_1-C_{18} alkyl group.

~~28~~25. The composition of claim ~~26~~ 23 wherein the acidic phosphate ester is a phosphate ester of an ethoxylated isodecyl alcohol, an ethoxylated tridecyl alcohol, an ethoxylated tristyrylphenol, or an ethoxylated nonylphenol.

~~29. The composition of claim 26 wherein the alkanolamide is cocamide MEA, cocamide DEA, lauramide MEA, lauramide DEA, oleamide MEA, oleamide DEA, cocamide MIPA, lauramide MIPA, or oleamide MIPA.~~

~~30~~26. The composition of claim ~~26~~ 23 consisting essentially of 45 to ~~55~~ 50 wt.% of the alkylbenzene sulfonic acid or acidic phosphate ester and ~~45~~ 50 to 55 wt.% of the ~~alkanolamide, ethoxylated alkanolamide,~~ alkanolamine, or ethoxylated amine having an average of 2 to 4 EO units.

27. The composition of claim **23**, wherein the ethoxylated amine has an average of 2 to 3 EO units.

28. The composition of claim **23**, wherein the ethoxylated amine has an average of 2 EO units.

~~31~~**29.** A mixture comprising solder and the composition of claim ~~26~~**23**.

~~32~~**30.** A method of making a solder flux composition, the method comprising: (a) combining ~~40~~ 45 to ~~60~~ 50 wt.% of an alkylbenzene sulfonic acid or an acidic phosphate ester with ~~40~~ 50 to ~~60~~ 55 wt.% of ~~an alkanolamide, an ethoxylated alkanolamide,~~ an alkanolamine, or an ethoxylated amine having an average of 2 to 4 EO units, and (b) mixing until the composition is substantially homogeneous.

31. The method of claim **30**, wherein the ethoxylated amine has an average of 2 to 3 EO units.

32. The method of claim **30**, wherein the ethoxylated amine has an average of 2 EO units.

33. A method which comprises using the composition of claim **1** as a component of a tacky solder flux.