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(54) **SOLVENT COMPOSITIONS CONTAINING 1,2,2-TRIFLUORO-1-TRIFLUORO-METHYLCYCLOBUTANE (TFMCB)**

(71) Applicant: **Honeywell International Inc.**, Morris Plains, NJ (US)

(72) Inventors: **Rajiv Ratna Singh**, Getzville, NY (US); **Ryan J. Hulse**, Getzville, NY (US); **Bin Yu**, Morris Plains, NJ (US)

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(57) **ABSTRACT**

The use of compositions comprising 1,2,2-trifluoro-1-trifluoromethyl cyclobutane (TFMCB) as a solvent are disclosed, wherein the TFMCB may be formulated into solvent compositions including a co-solvent such as ethanol or trans-dichloroethylene (trans-DCE). The solvent compositions may be in the form of a sprayable aerosol composition, and may be used for applications including degreasing or removal of coatings such as paints and adhesives.

SOLVENT COMPOSITIONS CONTAINING 1,2,2-TRIFLUORO-1-TRIFLUORO-METHYLCYCLOBUTANE (TFMCB)

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Application Nos. 62/784,020, filed Dec. 21, 2018, 62/784,035, filed Dec. 21, 2019, 62/784,041, filed Dec. 21, 2019, and 62/784,049, filed Dec. 21, 2019, all of which are herein incorporated by reference in their entireties.

FIELD

[0002] The present disclosure is related to solvent compositions comprising 1,2,2-trifluoro-1-trifluoromethylcyclobutane (TFBCB), and methods for using these compositions.

BACKGROUND

[0003] Fluorocarbon fluids have properties that are desirable for use in a variety of applications, including as solvents, and other applications. Unfortunately, the use of certain hydrofluorocarbons "HFCs" in industrial applications is now believed to contribute to the global warming, and accordingly, have limited their contemporary use. However, the identification of new, environmentally-safe compositions comprising HFCs is complicated, due to the fact that many properties which make them useful in these applications are not readily predictable.

[0004] While many of the hydrochlorofluorocarbons described heretofore may have substantial solvent power with respect to certain oils and fats, many also have certain disadvantages. For example, some of these compounds may tend to attack substrates, particularly general-purpose plastics such as acrylic resins and ABS resins. Also, such compounds may not be sufficiently volatile to act as effective solvents in certain vapor degreasing operations, and the relatively low vapor pressure of such compounds may make it difficult to remove the solvent composition from the parts being cleaned.

[0005] Flammability is another important property for many applications. That is, it is considered either important or essential in many applications, including particularly in solvent cleaning applications, to use compositions which are non-flammable. Thus, it is frequently beneficial to use in such compositions compounds which are nonflammable. Unfortunately, many HFC's which might otherwise be desirable for use in solvent compositions are not nonflammable. For example, the fluoroalkane pentafluorobutane (HFC-365) is flammable and therefore not viable for use in many applications.

[0006] Thus, it is desirable that solvent compositions not only have acceptable environmental properties, but also chemical stability, low- or no-toxicity, low or no-flammability, among others.

[0007] Therefore, the industry is continually seeking new HFC-based mixtures that are acceptable and environmentally safer substitutes to the incumbent compositions and have excellent performance when in use.

SUMMARY

[0008] Compositions comprising 1,2,2-trifluoro-1-trifluoromethyl cyclobutane (TFMCB) as solvents are disclosed, wherein the TFMCB may be formulated into solvent compositions including a co-solvent such as ethanol or trans-dichloroethylene (trans-DCE). The solvent compositions may be in the form of a sprayable aerosol composition and may be used for applications including degreasing or removal of coatings such as paints and adhesives.

[0009] In one form, the present disclosure provides a solvent composition comprising at least about 5% by weight of 1-trifluoromethyl-1,2,2-trifluorocyclobutane (TFMCB) and at least one co-solvent.

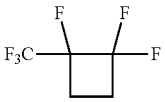
[0010] The co-solvent may be ethanol, and the solvent composition may comprise from about 95% to about 99% by weight of TFMCB and from about 1% to about 5% by weight ethanol.

[0011] The co-solvent may be trans-dichloroethylene (trans-DCE), and the solvent composition may comprise a non-azeotropic mixture of less than about 50% by weight of TFMCB and greater than about 50% by weight trans-dichloroethylene (trans-DCE).

DETAILED DESCRIPTION

[0012] Applicants have found that the above-noted needs, and other needs, can be satisfied by methods, processes, and the use of solvent compositions comprising TFMCB.

[0013] The compound 1,2,2-trifluoro-1-trifluoromethyl-cyclobutane ("TFMCB") has the following chemical structure:



[0014] 1,2,2-trifluoro-1-trifluoromethylcyclobutane ("TFMCB") may also be referred to by alternative names, including 1,2,2-trifluoro-1-trifluoromethyl cyclobutane, 1-trifluoromethyl-1,2,2-trifluorocyclobutane, 1,1,2-trifluoro-2-trifluoromethyl-cyclobutane, or hexafluoropropylene/ethylene cyclic dimer.

[0015] TFMCB may be manufactured by any appropriate method. Suitable methods include those set out in U.S. Pat. No. 9,856,193 and U.S. Pat. No. 10,005,705, the entire of which are hereby incorporated by reference.

[0016] "Global Warming Potential" (hereinafter "GWP") was developed to allow comparisons of the global warming impact of different gases. It is a measure of how much energy the emission of one ton of a gas will absorb over a given period of time, relative to the emission of one ton of carbon dioxide. The larger GWP, the more that a given gas warms the Earth compared to CO_2 over that time period. The time period usually used for GWP is 100 years. GWP provides a common measure, which allows analysts to add up emission estimates of different gases. See Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5), 2014. TFMCB has a GWP of 44 as calculated from the atmospheric lifetime and radiative efficiency (Reference for procedure: Hodnebrog, Etminan, Fuglestvedt, Marston, Myhre, Nielsen, Shine, Wallington "Global Warming Potentials and Radiative Efficiencies of Halocarbons and Related Compounds: A Comprehensive Review" *Reviews of Geophysics,* 51, 2013. DOI: 8755-1209/13/10.1002/rog.20013. TFMCB has a GWP of about 44.

[0017] LC_{50} is a measure of the acute toxicity of a compound. The acute inhalation toxicity of a compound can be assessed using the method described in the OECD Guideline for Testing of Chemicals No. 403 "Acute Inhalation Toxicity" (2009), Method B.2. (Inhalation) of Commission Regulation (EC) No. 440/2008. TFMCB has an LC_{50} of >19.15 mg/L.

[0018] The flash point of a solvent refers the lowest temperature at which vapors of the liquid will keep burning after the ignition source is removed as determined in accordance with ASTM D3828. Solvents which do not have a flash point below 100° F. (37.8° C.) are classified as "non-flammable" in accordance with NFPA 30: Flammable and Combustible Liquid Code.

[0019] TFMCB may be manufactured by any appropriate method. Suitable methods include those set out in U.S. Pat. No. 9,856,193 and U.S. Pat. No. 10,005,705, the entire of which are hereby incorporated by reference.

[0020] The present disclsoure relates to solvent compositions comprising 1-trifluoromethyl-1,2,2-trifluorocyclobutane (TFMCB).

[0021] The solvent may comprise the TFMCB in an amount of at least about 5% by weight, preferably at least about 15% by weight, more preferably at least about 30% by weight, more preferably at least about 50% by weight, more preferably at least about 60% by weight, more preferably at least about 70% by weight, more preferably at least about 90% by weight, more preferably at least about 95% by weight of the composition, more preferably at least about 99% by weight of the composition. Other particular compositions are described in detail below.

[0022] It will be appreciated that any of the above amounts may be used to provide end points for ranges of the amount of TFMCB in the solvent composition. For example, the TFMCB may be present in an amount of from about 1% to about 99% by weight of the composition, or from about 10% to about 90% by weight of the composition or from about 10% to about 60% by weight of the composition, or from about 90% to about 99% by weight of the composition.

[0023] It will be appreciated that the solvent may consist essentially of, or consist of, TFMCB.

[0024] The solvent composition may include one or more co-solvents, selected from the group consisting of a linear, branched or cyclic hydrocarbon, a ketone, an ester, an ether, an acetal, trans-dichloroethylene (trans-DCE), an alcohol (preferably methanol, ethanol or propanol), HFO-1233zd (E), HFO-1233zd(Z), HFO-1336mzz(E), HFO-1336mzz(Z), and combinations thereof. Preferred co-solvents include trans-DCE, ethanol and propanol. It will be appreciated that the propanol may be n-propanol or isopropanol, preferably isopropanol.

[0025] The co-solvent may be present in an amount of at least about 1% by weight, at least about 10% by weight, at least about 30% by weight, at least about 50% by weight, at least about 70% by weight, at least about 90% by weight, or at least about 99% of the composition.

[0026] It will be appreciated that any of the above amounts may be used to provide end points for ranges of the amount of co-solvent in the solvent composition. For example, the co-solvent may be present in an amount of from about 1% to about 99% by weight of the composition, or from about 1% to about 90% by weight of the composition or from about 1% to about 10% by weight of the composition, or from about 40% to about 90% by weight of the composition.

[0027] It will be appreciated that the solvent composition may consist essentially of, or consist of, the TFMCB and co-solvent. The solvent composition may be a non-azeotropic mixture of the TFMCB and the co-solvent.

[0028] When the co-solvent is trans-DCE, it is preferably present in an amount of from about 40% to about 90% by weight of the solvent composition. The TFMCB is present in an amount of from about 10% to about 60% by weight of the solvent composition. The solvent may consist essentially of or consist of TFMCB and trans-DCE.

[0029] Still further, when the co-solvent is trans-DCE, the trans-DCE may be present in an amount of greater than 50% by weight, or may be present in an amount as little as 40% by weight, 50% by weight, or 60% by weight, or as great as 70% by weight, 80% by weight, or 90% by weight, or within any range between any two of the foregoing values as endpoints, such as from 40% to 90% by weight, from 50% to 80% by weight, and from 60% to 70% by weight, for example, and the TFMCB may be present in an amount of less than 50% by weight, or may be present in an amount as little as 10% by weight, 20% by weight, or 30% by weight, or as great as 40% by weight, 50% by weight, or 60% by weight, or within any range between any two of the foregoing values as endpoints, such as from 10% to 60% by weight, from 20% to 50% by weight, and from 30% to 40% by weight, for example.

[0030] When the co-solvent is an alcohol (preferably ethanol or propanol), it is preferably present in an amount of from about 1% to about 10% by weight of the solvent composition. The TFMCB is present in an amount of from about 90% to about 99% by weight of the solvent composition. The solvent may consist essentially of, or consist of, TFMCB and alcohol (preferably ethanol or propanol). The propanol may be n-propanol or isopropanol, preferably isopropanol. When the co-solvent is ethanol, it is preferably present in an amount of from about 1% to about 5% by weight of the solvent composition. The TFMCB is present in an amount of from about 95% to about 99% by weight of the solvent composition. The solvent may consist essentially of, or consist of, TFMCB and ethanol.

[0031] Still further, when the co-solvent is ethanol, the ethanol may be present in an amount of greater than 1% by weight, or may be present in an amount as little as 1 by weight, 2% by weight, or 2.5% by weight, or as great as 3.5% by weight, 4% by weight, or 5% by weight, or within any range between any two of the foregoing values as endpoints, such as from 1% to 5% by weight, from 2% to 4% by weight, and from 2.5% to 3.5% by weight, for example, and the TFMCB may be present in an amount of at least 95% by weight, or may be present in an amount as little as 95% by weight, 96% by weight, or 96.5% by weight, or as great as 97.5% by weight, 98% by weight, or 99% by weight, or within any range between any two of the foregoing values as endpoints, such as from 95% to 99% by weight, from 96% to 98% by weight, and from 96.5% to 97.5% by weight, for example.

[0032] When the TFMCB is used in a solvent along with a co-solvent, the solvent composition comprises the TFMCB and co-solvent with the proviso that the solvent composition is not an azeotrope which is an admixture of about 21 to 27 weight percent TFMCB, 64 to 72 weight percent trans-1,2-dichloroethylene and about 5 to 11 weight percent methanol and the solvent composition is not an azeotropic composition which is an admixture of about 82 to 92 weight percent

TFMCB and about 8 to 18 weight percent methanol or an admixture of about 82 to 92 weight percent TFMCB and about 8 to 18 weight percent ethanol.

[0033] The solvent composition preferably has a GWP of not greater than about 1000, more preferably not greater than about 500, more preferably not greater than about 150.

[0034] It has been surprisingly discovered that TFMCB is non-flammable. Thus, the solvent composition is preferably non-flammable (e.g. preferably it has no flash point, or a flash point of above about 100° F.).

[0035] The solvent composition may include anticorrosive agents, surfactants, stabilizers, inhibitors and other adjuvants which assist with or enhance the functionality of the composition. Examples of stabilizers include nitroalkanes, epoxy alkanes and phosphite esters.

[0036] One of the most important characteristics of the present invention as it relates to solvent applications is that the present compositions have been found to have a high level of solvent power for many common contaminants and residues while at the same time not having a high degree of acute toxicity.

[0037] The invention provides a method of removing a contaminant from an article comprising contacting the contaminated article with a solvent composition of the invention. Preferably, the method comprises applying a solvent composition of the present invention to the article containing the contaminant, by vapor degreasing or solvent cleaning methods. Such methods are particularly preferred for certain applications, especially those especially intricate parts and difficult to remove soils. As those skilled in the art will appreciate, the present methods have applicability to a wide variety of different cleaning and residue removal techniques, and all such techniques are within the broad scope of the present invention.

[0038] Preferred vapor degreasing and solvent cleaning methods comprise the step of exposing an article, preferably at room-temperature (e.g. about 25° C.), to the vapors of the boiling solvent composition. Vapors condensing on the object have the advantage of providing a relatively clean, distilled solvent to wash away grease or other contamination. Such processes thus have an additional advantage in that final evaporation of the present solvent composition from the object leaves behind relatively little residue as compared to the case where the object is simply washed in liquid solvent.

[0039] For applications in which the article includes contaminants that are difficult to remove, it is preferred that the present methods involve raising the temperature of the solvent composition of the present invention above ambient (e.g. above about 25° C.) or to any other temperature that is effective in such application to substantially improve the cleaning action of the solvent. Such processes are also generally preferred for large volume assembly line operations where the cleaning of the article, particularly metal parts and assemblies, must be done efficiently and quickly.

[0040] Preferably, the cleaning methods of the present invention comprise immersing the article to be cleaned in liquid solvent at an elevated temperature, and even more preferably at about the boiling point of the solvent composition. In such operations, this step preferably removes a substantial amount, and even more preferably a major portion, of the target contaminant from the article. This step is then preferably followed by immersing the article in solvent, preferably freshly distilled solvent, which is at a temperature below the temperature of the liquid solvent in the preceding immersion step, preferably at about ambient or room temperature (e.g. about 25° C.). The preferred methods also include the step of then contacting the article with relatively hot vapor of the present solvent composition, preferably by exposing the article to solvent vapors rising from the hot/boiling solvent associated with the first mentioned immersion step. This preferably results in condensation of the solvent vapor on the article. It will be appreciated that the article may be sprayed with distilled solvent before final rinsing.

[0041] It is contemplated that numerous varieties and types of vapor degreasing equipment may be used in connection with the present methods. One example of such equipment and its operation is disclosed by Sherliker et al. in U.S. Pat. No. 3,085,918, which is incorporated herein by reference. The equipment disclosed in Sherliker et al includes a boiling sump for containing a solvent composition, a clean sump for containing distilled solvent, a water separator, and other ancillary equipment.

[0042] The present cleaning methods may also comprise cold cleaning in which the contaminated article is either immersed in the solvent composition of the present invention under ambient or room temperature conditions (e.g. about 25° C.) or wiped under such conditions with rags or similar objects soaked in solvents. In addition, the present methods may comprise the step of applying the solvent composition to the article by spraying the composition onto the article.

[0043] The solvent compositions of the invention are capable of effectively displacing water from a broad range of substrates including, without limitation: metals, such as stainless steel, aluminum alloys, and brass; glass and ceramic surfaces, such as glass, borosilicate glass and unglazed alumina; silica, such as silicon wafers; fired alumina; and the like. Further, the solvent compositions of the invention either do not form noticeable emulsions with the displaced water or form only insignificant amounts of such emulsions.

[0044] The solvent compositions of the invention may be used to clean and/or dry nonabsorbent substrates and articles constructed of such materials as metals, glasses, ceramics, and the like. Thus, the invention provides a method for drying the surface of a substrate comprising the steps of contacting the substrate with a solvent composition of the invention then removing the solvent composition from the article.

[0045] The solvent compositions of the invention may be used to remove coatings, such as paints and adhesives, from the surfaces of articles, in order to clean the and/or prepare the surfaces for subsequent modification such as by coating, for example.

[0046] The manner of contacting is not critical and may vary widely. For example, the article may be immersed in a container of the composition or the article may be sprayed with the composition. Complete immersion of the article is preferred because it ensures contact between all exposed surfaces of the article and the composition. Any method that can provide such contact may be used. Typically, the contacting time is up to about 10 minutes, but this time is not critical and longer times may be used if desired.

[0047] The contacting temperature may also vary widely depending on the boiling point of the solvent compositions. In general, the temperature is equal to or less than about such

boiling point. Following the contacting step, the article is removed from contact with the composition and removal of composition adhering to exposed surfaces of the article is effected by any conventional means such as evaporation.

[0048] The solvent compositions may be used in an aerosol and/or a sprayable composition. Preferably, the aerosol and/or sprayable composition may have one or more additives designed for this use, such as propellants, atomizing agents and the like.

[0049] One such composition is an aerosol spray composition for degreasing and other cleaning applications, in which the compositions is disposed in a spray can or other spray delivery device along with a suitable propellant. In particular, solvent compositions including mixtures of TFMCB and ethanol at various weight proportions may be loaded into aerosol cans. An aerosol valve may be crimped into place on each can and HFC-134a propellant may be added through the valves to achieve a pressure in the cans of about 20 PSIG.

[0050] The solvent may be provided as a sprayable composition comprising the solvent as described above, an active ingredient, and optionally, other components such as inert ingredients, other solvents, and the like.

[0051] The sprayable composition may be used in cleaning and degreasing applications such as those described above.

[0052] Alternatively, other suitable active materials to be sprayed include, without limitation, cosmetic materials such as deodorants, perfumes, hair sprays, cleaning solvents, lubricants, insecticides as well as medicinal materials, such as anti-asthma medications. The term medicinal materials is used herein in its broadest sense to include any and all materials which are, or at least are believe to be, effective in connection with therapeutic, diagnostic, pain relief, and similar treatments, and as such would include for example drugs and biologically active substances.

[0053] The solvent compositions described herein can be used as a solvent in cleaning various soils such as paints, coatings, adhesives, mineral oil, rosin-based fluxes, silicon oils, lubricants, etc., from various substrates by wiping, vapor degreasing, or other means. In certain preferred embodiments, the cleaning composition is an aerosol.

[0054] The solvent compositions of the invention may be used as a carrier. For example, the solvent compositions may be used as a carrier for an organic substance, such as a lubricant, a coating material, a mold release agent, a water/oil repellant, an oil or a grease. The oil may be mineral oil, cutting oil or silicone oil.

[0055] It will also be appreciated that the solvent compositions of the invention may be used as a carrier for a flavor formulation or fragrance formulation.

[0056] In the manufacture of electronic circuit assemblies, contamination can accumulate throughout the various steps of the fabrication process. One of the final steps in the fabrication process is the application of soldering flux, followed by various soldering operations. The cleanliness of electronic circuit assemblies such as printed circuit boards is critical to their proper function and reliability. In practice, however, these fluxes have proven difficult to effectively remove. Thus, the solvent compositions of the invention may be used to clean an electronic circuit assembly, such as a printed circuit board, during the fabrication thereof. In this use, the solvent compositions may clean solder flux residues from the electronic circuit assembly. The solder flux may be a rosin or a non-rosin (or water soluble) flux.

[0057] The solvent compositions of the invention may be used to solvate an oil, for example, mineral oil, cutting oil or silicone oil.

[0058] The solvent compositions of the invention may also be used as an extractant. For example, they may be used to extract organic compounds (e.g. they may be used to extract biomass or fragrances from plant matter)

[0059] The following examples are provided for the purpose of illustrating the present invention but without limiting the scope thereof.

EXAMPLES

Example 1

[0060] The performance of a solvent-solvent composition of the invention in the displacement of water is evaluated by placing 35 mL of solvent (which is TFMCB and optionally 5% by weight trans-DCE, ethanol, isopropanol or n-propanol) in a 100 mL beaker fitted with a cooling coil. The solution is brought to a boil whereby the coiling coil confines the solvent vapor to the beaker. Duplicate 316 stainless steel coupons, wet abraded to a water-break-free condition, are immersed in water and then into the boiling sample solution. The time required to displace the water from the coupon is recorded using a minimum observation time of 5 seconds. The solvent alcohol blend could remove water completely from the substrate.

Example 2

[0061] A solvent (which is TFMCB and optionally 5% by weight trans-DCE, ethanol, isopropanol or n-propanol) is demonstrated to be an acceptable carrier and extraction agent for Jasmone. Approximately 0.39 g of Jasmone is added to a heavy walled glass tube and approximately 1.73 g of solvent (and optional co-solvent) are added to the glass tube. The tube is then frozen and sealed. Upon thawing the tube, it is observed whether the composition has one liquid phase. This example demonstrates that fragrances, such as plant-derived fragrances (e.g. Jasmone) are soluble in the solvent compositions of the invention, and thus the solvent compositions can be used as an extractant or carrier.

Example 3

[0062] An oil (specifically mineral oil, silicone oil or a cutting oil) is added to a vial containing A solvent (which is TFMCB and optionally 5% by weight trans-DCE, ethanol, isopropanol or n-propanol). A homogeneous single phase solution is formed at concentrations of greater than 10% by weight of oil.

Example 4

[0063] Solvent compositions including mixtures of TFMCB and ethanol and mixtures of TFMCB and trans-dichloroethylene (DCE) at various weight proportions are loaded into aerosol cans. An aerosol valve is crimped into place on each can and HFC-134a is added through the valves to achieve a pressure in the cans of about 20 PSIG. The mixtures are then sprayed onto surfaces demonstrating that the compositions are useful as an aerosol.

[0064] Additionally, the aerosol compositions are sprayed onto surfaces which include oil, grease, dirt, or solder flux, and are effective in solvating and removing such materials.

Example 5

[0065] A mixture containing 98% by weight TFMCB and 2% by weight ethanol is loaded into an aerosol can. An aerosol valve is crimped into place and HFC-134a is added through the valve to achieve a pressure in the can of about 20 PSIG. The mixture is then sprayed onto a metal coupon soiled with solder flux. The flux is removed and the coupon is visually clean.

Example 6

[0066] Example 5 above is repeated, except the method of applying the composition as a cleaning agent is vapor degreasing or wiping instead of spraying. Optionally, the cleaning agent is applied neat. Optionally, the material to be cleaned was changed from solder flux to a mineral oil, silicon oil, or other lubricant. Similar results are demonstrated in each case.

Example 7

[0067] Mixtures are prepared containing 98% by weight TFMCB with about 2 weight percent ethanol. Several stainless steel coupons are soiled with mineral oil. Then these coupons are immersed in these solvent blends. The blends remove the oils in a short period of time. The coupons are observed visually and look clean.

Example 8

[0068] A mixture containing 40% by weight TFMCB and 60% by weight trans-dichloroethylene (DCE) is used as a cleaning agent in vapor degreasing or wiping. Optionally, the cleaning agent is applied neat. Optionally, the material to be cleaned was changed from solder flux to a mineral oil, silicon oil, or other lubricant. Similar results are demonstrated in each case.

Example 9

[0069] An aerosol solvent blend is prepared containing 98% by weight of TFMCB and 2% by weight of ethanol as in Example 4. Kester 1544 Rosin Soldering Flux is placed on stainless steel coupons and heated to approximately 300-400° F., which simulates contact with a wave soldier normally used to solder electronic components in the manufacture of printed circuit boards. The coupons are then sprayed with the solvent mixture and removed after 15 seconds without rinsing. Results show that the coupons appeared clean by visual inspection.

Example 10

[0070] A mixture containing 40% by weight TFMCB and 60% by weight trans-dichloroethylene (DCE) is used as a solvating agent for removing paints, coatings and adhesives from surfaces. The solvating agent is effective for solvating the paints, coatings and adhesives and allowing the removal of same from the surfaces.

ASPECTS

[0071] The invention will now be illustrated by reference to the following numbered embodiments. The subject matter of the numbered embodiments may be additionally combined with subject matter from the description or from one or more of the claims.

[0072] Aspect 1 is a solvent composition comprising at least about 5% by weight of 1-trifluoromethyl-1,2,2-trifluorocyclobutane (TFMCB) and at least one co-solvent.

[0073] Aspect 2 is the solvent composition of Aspect 1, wherein the co-solvent is selected from the group consisting of ethanol and trans-dichloroethylene (trans-DCE).

[0074] Aspect 3 is an aerosol and/or a sprayable composition comprising the solvent composition of Aspect 1 or Aspect 2.

[0075] Aspect 4 is a method of removing a contaminant from an article comprising contacting the contaminated article with the solvent composition of Aspect 1 or Aspect 2.

[0076] Aspect 5 is the method of claim Aspect 4, wherein the article is selected from the group consisting of a metal, a glass, silica, and alumina.

[0077] Aspect 6 is a method of removing a coating from an article comprising contacting the contaminated article with the solvent composition of Aspect 1 or Aspect 2.

[0078] Aspect 7 is the method of Aspect 6, wherein the coating is selected from the group consisting of a paint and an adhesive.

[0079] Aspect 8 is the solvent composition of Aspect 1 or Aspect 2, wherein the solvent composition has a Global Warming potential (GWP) of not greater than about 1000.

[0080] Aspect 9 is the solvent composition of Aspect 1 or Aspect 2, wherein the co-solvent is ethanol, and the solvent comprises from about 95% to about 99% by weight of TFMCB and from about 1% to about 5% by weight ethanol.

[0081] Aspect 10 is the solvent composition of Aspect 9, wherein the co-solvent is ethanol, and the solvent comprises from about 96% to about 98% by weight of TFMCB and from about 2% to about 4% by weight ethanol.

[0082] Aspect 11 is an aerosol and/or a sprayable composition comprising the solvent composition of Aspect 9 or Aspect 10.

[0083] Aspect 12 is a method of removing a contaminant from an article comprising contacting the contaminated article with the solvent composition of Aspect 9 or Aspect 10.

[0084] Aspect 13 is the method of Aspect 12, wherein the article is selected from the group consisting of a metal, a glass, silica, and alumina.

[0085] Aspect 14 is the solvent composition of Aspect 2, wherein the co-solvent is trans-dichloroethylene (trans-DCE), and the solvent comprises a non-azeotropic mixture of less than about 50% by weight of TFMCB and greater than about 50% by weight trans-dichloroethylene (trans-DCE).

[0086] Aspect 15 is the solvent composition of Aspect 14, wherein the co-solvent is trans-dichloroethylene (trans-DCE), and the solvent comprises a non-azeotropic mixture of from about 10% to about 50% by weight of TFMCB and from about 50% to about 90% by weight trans-dichloroethylene (trans-DCE).

[0087] Aspect 16 is the solvent composition of Aspect 15, wherein the co-solvent is trans-dichloroethylene (trans-DCE), and the solvent comprises a non-azeotropic mixture

of from about 20% to about 40% by weight of TFMCB and from about 60% to about 80% by weight trans-dichloroethylene (trans-DCE).

[0088] Aspect 17 is a method of removing a coating from an article comprising contacting the contaminated article with the solvent composition of any of Aspects 14-16.

[0089] Aspect 18 is the method of Aspect 17, wherein the coating is selected from the group consisting of a paint and an adhesive.

[0090] Aspect 19 is the solvent composition of any of Aspects 14-16, wherein the solvent composition has a Global Warming potential (GWP) of not greater than about 1000.

[0091] As used herein, the phrase "within any range defined between any two of the foregoing values" literally means that any range may be selected from any two of the values listed prior to such phrase regardless of whether the values are in the lower part of the listing or in the higher part of the listing. For example, a pair of values may be selected from two lower values, two higher values, or a lower value and a higher value.

[0092] It should be understood that the foregoing description is only illustrative of the present disclosure. Various alternatives and modifications can be devised by those skilled in the art without departing from the disclosure. Accordingly, the present disclosure is intended to embrace all such alternatives, modifications and variances that fall within the scope of the appended claims.

What is claimed is:

1. A solvent composition comprising at least about 5% by weight of 1-trifluoromethyl-1,2,2-trifluorocyclobutane (TFMCB) and at least one co-solvent.

2. The solvent composition of claim **1**, wherein the co-solvent is selected from the group consisting of ethanol and trans-dichloroethylene (trans-DCE).

3. An aerosol and/or a sprayable composition comprising the solvent composition of claim **2**.

4. A method of removing a contaminant from an article comprising contacting the contaminated article with the solvent composition of claim **2**.

5. The method of claim **4**, wherein the article is selected from the group consisting of a metal, a glass, silica, and alumina.

6. A method of removing a coating from an article comprising contacting the contaminated article with the solvent composition of claim **2**.

7. The method of claim **6**, wherein the coating is selected from the group consisting of a paint and an adhesive.

8. The solvent composition of claim **2**, wherein the solvent composition has a Global Warming potential (GWP) of not greater than about 1000.

9. The solvent composition of claim **2**, wherein the co-solvent is ethanol, and the solvent composition comprises from about 95% to about 99% by weight of TFMCB and from about 1% to about 5% by weight ethanol.

10. The solvent composition of claim **9**, wherein the co-solvent is ethanol, and the solvent composition comprises from about 96% to about 98% by weight of TFMCB and from about 2% to about 4% by weight ethanol.

11. An aerosol and/or a sprayable composition comprising the solvent composition of claim **9**.

12. A method of removing a contaminant from an article comprising contacting the contaminated article with the solvent composition of claim **9**.

13. The method of claim **12**, wherein the article is selected from the group consisting of a metal, a glass, silica, and alumina.

14. The solvent composition of claim **2**, wherein the co-solvent is trans-dichloroethylene (trans-DCE), and the solvent composition comprises a non-azeotropic mixture of less than about 50% by weight of TFMCB and greater than about 50% by weight trans-dichloroethylene (trans-DCE).

15. The solvent composition of claim **14**, wherein the co-solvent is trans-dichloroethylene (trans-DCE), and the solvent composition comprises a non-azeotropic mixture of from about 10% to about 50% by weight of TFMCB and from about 50% to about 90% by weight trans-dichloroethylene (trans-DCE).

16. The solvent composition of claim **15**, wherein the co-solvent is trans-dichloroethylene (trans-DCE), and the solvent composition comprises a non-azeotropic mixture of from about 20% to about 40% by weight of TFMCB and from about 60% to about 80% by weight trans-dichloroethylene (trans-DCE).

17. A method of removing a coating from an article comprising contacting the contaminated article with the solvent composition of claim **14**.

18. The method of claim **17**, wherein the coating is selected from the group consisting of a paint and an adhesive.

19. The solvent composition of claim **14**, wherein the solvent composition has a Global Warming potential (GWP) of not greater than about 1000.

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