FLUOROPOLYMER COMPOSITIONS AND COATINGS

Field

The present disclosure relates to fluoropolymer compositions in particular suitable for coating substrates, coated articles and methods of making the compositions and the coatings.

Background

Fluoropolymers, in particular highly fluorinated polymers, such as polymers with a high content of tetrafluoroethene (TFE), have achieved outstanding commercial success due to their chemical and thermal inertness. They are used in a wide variety of applications in which severe environments such as exposure to high temperatures and/or aggressive chemicals are encountered. Typical end use applications of the polymers include but are not limited to seals for engines, seals in oil-well drilling devices, and sealing elements for industrial equipment that operates at high temperatures or in a chemically aggressive environment.

The outstanding properties of the highly fluorinated polymers are largely attributable to the stability and inertness of the copolymerized perfluorinated monomer units that make up the major portion of the polymer backbones in these compositions. Such monomers include tetrafluoroethene and other perfluorinated alpha-olefins.

However, highly fluorinated polymers, in particular perfluoroelastomers, are difficult to dissolve in solvents and coating compositions are difficult to prepare. Therefore, articles containing these polymers are typically prepared by molding the polymers. In international patent application WO2008/094758 A1 certain perfluorinated liquids are reported to dissolve perfluoroelastomers and were suggested for making coating compositions.

There is a need to provide further compositions with dissolved highly fluorinated polymers for coating substrates.

Summary

Therefore, there is provided a composition comprising at least one fluoropolymer and at least one solvent, wherein the solvent comprises a branched, partially fluorinated ether and wherein the partially fluorinated ether corresponds to the formula:

Rf-O-R

wherein Rf is a selected from perfluorinated and partially fluorinated alkyl groups that may be interrupted once or more than once by an ether oxygen and R is selected from partially fluorinated and non-fluorinated alkyl groups;

and wherein the fluoropolymer is a copolymer comprising at least 90 % by weight (based on the total weight of the polymer, which is 100 % by weight) of units derived from tetrafluoroethene (TFE) and one or more perfluorinated alkyl ethers corresponding to the general formula

$$R_f\text{-}O\text{-}(CF_2)_n\text{-}CF{=}CF_2$$

wherein n is 1 or 0 and R_f represents a perfluoroalkyl residue which may be interrupted once or more than once by an oxygen atom.

In one aspect there is provided a composition comprising at least one fluoropolymer dissolved in at least one solvent, wherein the solvent comprises a branched, partially fluorinated ether and wherein the partially fluorinated ether corresponds to the formula:

$$C_pF_{2p+1}\text{-}O\text{-}C_qH_{2q+1}$$

wherein q is an integer from 1 to 5 and p is an integer from 5 to 11;

and wherein the fluoropolymer is a copolymer comprising at least 90 % by weight (based on the total weight of the polymer, which is 100 % by weight) of units derived from tetrafluoroethene (TFE) and one or more perfluorinated alkyl ethers corresponding to the general formula

$$R_f\text{-}O\text{-}(CF_2)_n\text{-}CF{=}CF_2$$

wherein n is 1 or 0 and Rf represents a perfluoroalkyl residue which may be interrupted once or more than once by an oxygen atom.

In another aspect there is provided a method of making the above composition comprising dissolving the fluoropolymer in the solvent.

In a further aspect there is provided an article comprising a coating obtained from the above composition.

There is also provided a method of making a coating comprising

(i) Applying a composition as above to a substrate;

(ii) removing the solvent and, optionally when the fluoropolymer is curable, subjecting the composition to curing, wherein the optional curing step may be carried out after, simultaneously with or prior to removing the solvent.

In yet another aspect there is provided a method of making a coated substrate comprising

(i) applying a composition as defined above to the substrate; and

(ii) removing the solvent.

Detailed Description

Before any embodiments of this disclosure are explained in detail, it is to be understood that the disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the following description. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description. Contrary to the use of "consisting", the use of "including," "containing", "comprising," or "having" and variations thereof is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. The use of "a" or "an" is meant to encompass "one or more". Any numerical range recited herein describing a physical property or a concentration is intended to include all values from the lower value to the upper value of that range and including the endpoints. For example, a concentration range of from 1% to 50 % is intended to be an abbreviation and to expressly disclose the values between the 1 % and 50 %, such as, for example, 2 %, 40 %, 10 %, 30 %, 1.5 %, 3.9 % and so forth.

Unless indicated otherwise the total amounts of ingredients of a composition expressed as percentage by weight of that composition add up to 100 %, i.e. the total weight of the composition is always 100 % by weight unless stated otherwise.

Unless indicated otherwise the total amounts of ingredients of a composition expressed as percentage by mole of that composition add up to 100 %., i.e. the total amount of moles of the composition is always 100 % by mole unless stated otherwise.

Claims

1. A composition comprising at least one fluoropolymer dissolved in at least one solvent, wherein the solvent comprises a branched, partially fluorinated ether and wherein the partially fluorinated ether corresponds to the formula:

$$C_pF_{2p+1}\text{-}O\text{-}C_qH_{2q+1}$$

wherein q is an integer from 1 to 5 and p is an integer from 5 to 11;

and wherein the fluoropolymer is a copolymer comprising at least 90 % by weight (based on the total weight of the polymer, which is 100 % by weight) of units derived from tetrafluoroethene (TFE) and one or more perfluorinated alkyl ethers corresponding to the general formula

$$R_f\text{-}O\text{-}(CF_2)_n\text{-}CF{=}CF_2$$

wherein n is 1 or 0 and R_f represents a perfluoroalkyl residue which may be interrupted once or more than once by an oxygen atom.

2. The composition according to claim 1 wherein the solvent is present in an amount of at least 25 % by weight based on the total weight of the composition with the total weight of the composition being 100 % by weight.

3. The composition according to any one of the preceding claims wherein the C_pF_{2p+1}- unit is branched.

4. The composition of any one of the preceding claims wherein the composition comprises the partially fluorinated ether in an amount of from about 55 to 99.9 % by weight based on the weight of the total composition which is 100 % by weight.

5. The composition of any one of the preceding claims comprising from 0.01 to 55 % by weight of the fluoropolymer based on the weight of the total composition, which is 100 % by weight.

6. The composition of any one of the preceding claims wherein the fluoropolymer is a curable elastomer and further comprises units derived from one or more types of cure-site monomers.

7. The composition according to any one of the preceding claims wherein the fluoropolymer is a fluoroelastomer and contains one or more cure-sites that are reactive to a peroxide curing system.

8. The composition according to any one of the preceding claims wherein the fluoropolymer is a curable fluoroelastomer and contains cure sites derived from one or more cure site monomers wherein the cure sites are selected from cure sites containing nitrile groups, iodine groups, bromine groups and combinations thereof.

9. The composition according to any one of the preceding claims wherein the fluoropolymer is a curable perfluoroelastomer and does not contain any repeating units derived from a non-fluorinated or partially fluorinated comonomer but may contain units derived from a perfluorinated, partially or non-fluorinated cure site monomer and or units derived from one or more modifier monomers selected from perfluorinated, partially and non-fluorinated bisolefins, bisolefin-ethers and bisolefin polyethers.

10. The composition according to any one of the preceding claims wherein the fluoropolymer is a curable elastomer and further comprises cure sites and wherein the composition further comprises at least one curing agent for curing the fluoroelastomer.

11. The composition according to any one of the preceding wherein the composition is a coating composition selected from coating compositions for impregnating, spray coating, solvent casting, bar coating, screen printing, 3D-printing, painting, dip coating and roller coating.

12. Method of making the composition of any of claims 1 to 11 comprising dissolving the fluoropolymer in the solvent.

13. The method of claim 12 further comprising adding one or more curing agents suitable for curing the fluoropolymer to the composition wherein the one or more curing agent may be added to the

fluoropolymer prior, subsequent or simultaneously with dissolving the fluoropolymer in the solvent, and wherein the fluoropolymer is curable.

14. An article comprising a coating obtained from the composition according to any one of claims 1 to 11.

15. A method of making a coated substrate comprising

(i) applying a composition according to any one of claims 1 to 11 to the substrate; and

(ii) removing the solvent..

16. The method of claim 15, further comprising subjecting the composition to curing, wherein the curing step may be carried out after, simultaneously with or prior to removing the solvent.