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(71) **Applicant** *(for all designated States except US)*: **DOW GLOBAL TECHNOLOGIES LLC** [US/US]; 2040 Dow Center, Midland, MI 48674 (US).

(72) **Inventors; and**
(71) **Applicants** *(for all designated States except US)*: **MUNDRA, Manish, K.** [IN/US]; 1001 Easton Road #M616, Willow Grove, PA 19090 (US). **EATON, Robert, F.** [US/US]; 67 Mill Pond Road, Belle Mead, NJ 08502 (US). **GHOSH-DASTIDAR, Abhijit** [IN/US]; 20 Gunpowder Drive, East Brunswick, NJ 08816 (US).

(74) **Agent**: **BARTHEL, Ted, J.**; Whyte Hirschboeck Dudek S.C., 555 East Wells Street, Suite 1900, Milwaukee, WI 53202 (US).

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(54) **Title**: PLASTICIZER FOR COLOR RETENTION DURING HEAT AGING

(57) **Abstract**: The present disclosure is directed to a plasticizer, a polymeric composition containing the plasticizer, and conductors coated with the polymeric composition. The plasticizer includes a blend of an epoxidized soybean oil and a trans-esterified epoxidized fatty acid methyl ester. The trans-esterified epoxidized fatty acid methyl ester has an oxirane value greater than or equal to 6.8 %. The plasticizer, the polymeric composition, and the coated conductor retain color during heat aging.

PLASTICIZER FOR COLOR RETENTION DURING HEAT AGING

FIELD

[0001] The present disclosure is directed to a plasticizer with color retention during heat aging.

BACKGROUND

[0002] Plasticizers are compounds or mixtures of compounds that are added to polymer resins to impart softness and flexibility. Phthalic acid diesters (also known as "phthalates") are known plasticizers in many flexible polymer products, such as polymer products formed from polyvinyl chloride (PVC) and other vinyl polymers. Examples of common phthalate plasticizers include di-isononyl phthalate (DINP), diallyl phthalate (DAP), di-2-ethylhexyl-phthalate (DEHP), dioctyl phthalate (DOP) and diisodecyl phthalate (DIDP). Other common plasticizers, used for high temperature applications, are trimellitates and adipic polyesters. Mixtures of plasticizers are often used to obtain optimum properties.

[0003] Phthalate plasticizers have recently come under intense scrutiny by public interest groups that are concerned about the negative environmental impact of phthalates and potential adverse health effects in humans (especially children) exposed to phthalates.

[0004] A known phthalate-free plasticizer for use in polyvinyl chloride (PVC) formulations is epoxidized soy oil. A growing number of applications require phthalate-free plasticizer to retain color when subjected to heat. However, epoxidized soy oil discolors when subjected to heat.

[0005] Accordingly, a need exists for a plasticizer having little, or no, phthalate with reduced, or no, discoloration when subjected to heat.

SUMMARY

[0006] The present disclosure is directed to a plasticizer, a polymeric composition containing the plasticizer, and conductors coated with the polymeric composition. The plasticizer and the polymeric composition retain color during heat aging.

[0007] In an embodiment, a plasticizer is provided and includes a blend of an epoxidized soybean oil and a trans-esterified epoxidized fatty acid methyl ester. The trans-esterified epoxidized fatty acid methyl ester has an oxirane value greater than or equal to 6.8 %. The plasticizer has an APHA value from 250 to 650 when heat aged at 190°C for 100 minutes.

[0008] In an embodiment, a polymeric composition is provided and includes a vinyl chloride resin and a plasticizer. The plasticizer is the blend of epoxidized soybean oil and trans-esterified epoxidized fatty acid methyl ester described above. The polymeric composition has a Yellowness Index less than 165 when heat aged at 190°C for 100 minutes.

[0009] In an embodiment, a coated conductor is provided and includes a conductor and a coating on the conductor. The coating is formed from the polymeric composition composed of the vinyl chloride resin and the plasticizer. The plasticizer is the blend of epoxidized soybean oil and trans-esterified epoxidized fatty acid methyl ester described above. The coating has a Yellowness Index less than 165 when heat aged at 190°C for 100 minutes.

[0010] An advantage of the present disclosure is a phthalate-free plasticizer with color retention when subjected to heat.

[0011] An advantage of the present disclosure is a phthalate-free plasticized polymeric composition with color retention when subjected to heat.

DETAILED DESCRIPTION

1. Plasticizer

[0012] The present disclosure provides a plasticizer. In an embodiment, a plasticizer is provided and includes a blend of an epoxidized soybean oil and a trans-esterified epoxidized fatty acid methyl ester (TeFAME). The TeFAME has an oxirane value greater than or equal to 6.8 %. The blend has an APHA value from 250 to 650 when heat aged at 190°C for 100 minutes.

[0013] A "plasticizer" is a substance that lowers the modulus and tensile strength, and increases flexibility, elongation, impact strength, and tear strength of the polymeric resin (typically a thermoplastic polymer) to which it is added. A plasticizer may also lower the melting point of the polymeric resin, which lowers the glass transition temperature and enhances processability of the polymeric resin to which it is added. In an embodiment, the present plasticizer is a phthalate-free plasticizer, or is otherwise void of phthalate.

[0014] The plasticizer is a blend of epoxidized soybean oil and TeFAME. The term "epoxidized soybean oil" (or "eSO"), as used herein, is a soybean oil having at least one fatty acid moiety that contains at least one epoxide group. An "epoxide group" is a three-member cyclic ether (also called oxirane or an alkylene oxide) in which an oxygen atom is joined to

each of two carbon atoms that are already bonded to each other. Epoxidation may occur by way of reaction of the natural oil with percarboxylic acid and/or other peroxy compounds.

[0015] A "transesterified epoxidized fatty acid methyl ester" (or "TeFAME"), as used herein, is an epoxidized fatty acid methyl ester prepared by transesterifying eSO. An "epoxidized fatty acid methyl ester" (or "eFAME") is a C_4-C_{24} (saturated or unsaturated) carboxylic acid methyl ester with at least one epoxide group. Esterification is a process in which two reactants, typically an acid (such as a fatty acid) and an alcohol, are reacted with one another to form an ester. Transesterification is the process of exchanging the organic group R" of an ester with the organic group R' of an alcohol. The TeFAME is produced by transesterifying eSO with methanol and a catalyst, such as an acid or base catalyst.

[0016] In an embodiment, the TeFAME has an oxirane value from greater than 6.8 % to 13.6%, or 10.1%, or 7.4%.

[0017] The eSO and the TeFAME are blended to form a plasticizer. The plasticizer has an APHA value from 20, or 40 to 80, or 60 prior to heat aging.

[0018] In an embodiment, the plasticizer is formed by blending from 35 weight percent (wt%) to 65 wt% of the eSO with 65 wt% to 35 wt% of the TeFAME. Weight percent is based on total weight of the plasticizer.

[0019] In a further embodiment, the plasticizer is formed by blending from 25 wt % to 75 wt % eSO with from 75 wt% to 25 wt % TeFAME.

[0020] In an embodiment, the process includes adding an antioxidant to the plasticizer. Nonlimiting examples of antioxidant include Irganox® 1076 (Octadecyl-3-(3,5-di-tert.butyl-4-hydroxyphenyl)-propionate), Baeropan 9754KA (mixed metal soap of calcium and zinc fatty acid salts), and Lowinox® TBP-6 (2,2'-Thiobis(6-t-butyl-4-methylphenol)).

[0021] The present plasticizer may comprise two or more embodiments disclosed herein.

2. Polymeric composition

[0022] The present disclosure provides a polymeric composition that, in one embodiment, includes a vinyl chloride resin and the plasticizer as disclosed above. The polymeric composition has a Yellowness Index less than 165 when heat aged at 190°C for 100 minutes. In a further embodiment, the polymeric composition has a Yellowness Index from 130 to less than 165 when heat aged at 190°C for 100 minutes.

[0023] The term "vinyl chloride resin," as used herein, is a vinyl chloride polymer, such as polyvinyl chloride (PVC), or a vinyl chloride copolymer such as vinyl chloride/vinyl acetate copolymer, vinyl chloride/vinylidene chloride copolymer, vinyl chloride/ethylene copolymer or a copolymer prepared by grafting vinyl chloride onto ethylene/vinyl acetate copolymer. The vinyl chloride resin can also include a polymer blend of the above-mentioned vinyl chloride polymer or vinyl chloride copolymer with other miscible or compatible polymers including, but not limited to, chlorinated polyethylene, thermoplastic polyurethane, olefin polymers such as a methacryl polymer or acrylonitrile-butadiene-styrene polymer (ABS).

[0024] In an embodiment, the vinyl chloride resin is polyvinyl chloride (PVC). PVC is known to be thermoplastic as opposed to thermoset.

[0025] In an embodiment, the polymeric composition includes from 65 wt% to 85 wt% vinyl chloride resin, and from 35 wt % to 15 wt % of the plasticizer. In a further embodiment, the polymeric composition includes 75 wt % vinyl chloride resin and 25 wt % of the plasticizer. Weight percent is based on total weight of the polymeric composition with the total being 100%.

[0026] In an embodiment, the polymeric composition includes 75 wt % vinyl chloride resin, 12.5 wt % eSO and 12.5 wt % TeFAME. Weight percent is based on total weight of the polymeric composition.

[0027] In an embodiment, the polymeric composition includes an antioxidant in an amount from 0.01 wt % to 5 wt % based on the weight of the polymeric composition.

3. Additive

[0028] The polymeric composition may include one or more of the following optional additives: a filler, a flame retardant, a heat stabilizer, an anti-drip agent, a colorant, a lubricant, a low molecular weight polyethylene, a hindered amine light stabilizer, a UV light absorber, a curing agent, a booster, a retardant, a processing aid, a coupling agent, an antistatic agent, a nucleating agents, a slip agent, a viscosity control agent, a tackifier, an anti-blocking agent, a surfactant, an extender oil, an acid scavenger, a metal deactivator, and any combination thereof.

[0029] Applicant has surprisingly discovered that the present plasticizer composed of eSO and TeFAME, unexpectedly provides a plasticizer with color retention when heat aged.

[0030] The present polymeric composition may comprise two or more embodiments disclosed herein.

4. Coated Conductor

[0031] The present disclosure provides a coated conductor. The coated conductor includes a conductor and a coating on the conductor, the coating formed from the polymeric composition described above.

[0032] A "conductor," as used herein, is one or more wire(s) or fiber(s) for conducting heat, light, and/or electricity. The conductor may be a single-wire/fiber or a multi-wire/fiber and may be in strand form or in tubular form. Nonlimiting examples of suitable conductor include metals such as silver, gold, copper, carbon, and aluminum. The conductor may also be optical fiber made from either glass or plastic.

[0033] The coated conductor may be flexible, semi-rigid, or rigid. The coating (also referred to as a "jacket" or a "sheath" or "insulation") is on the conductor or on another polymeric layer around the conductor.

[0034] In an embodiment, the coating of the coated conductor has a Yellowness Index less than 165, or from 130 to less than 165 when the coated conductor is heat aged at 190°C for 100 minutes.

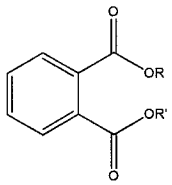
[0035] The present coated conductor may comprise two or more embodiments disclosed herein.

DEFINITIONS

[0036] The terms "comprising", "including", "having" and their derivatives do not exclude the presence of any additional component or procedure. The term, "consisting essentially of" excludes any other component or procedure, except those essential to operability. The term "consisting of" excludes any component or procedure not specifically stated.

[0037] In an embodiment, the compositions disclosed herein are phthalate-free. The term "phthalate-free composition," as used herein, is a composition devoid of phthalate or is otherwise free of phthalate. A "phthalate," is a compound which includes the following structure (I):

(I)



[0038] wherein R and R' may be the same or different.

TEST METHODS

[0039] APHA (American Public Health Association) color measurement is determined in accordance with ASTM E 1209 as set forth below. ASTM standards E1209 and E313 are followed to standardize results.

Plasticizer samples are prepared and measured using the protocol provided below:

- Instrument (BYK Gardner – LCM III) is set (via touch screen panel) to measure Hazen/Alpha indices
- Each sample to be measured is carefully syringed (10 ml) into individual calibrated cuvette.
- Each loaded cuvette is carefully placed into the LCS III and the test button was pushed, after a few seconds a Hazen/Alpha number is generated. This number is recorded, the sample is then removed and placed back into the LCS III and measured a second time (data was recorded) and sample is measured a third time (data recorded).
- The loaded cuvette is removed and set aside, the LCS III is then reset to measure Yellowness Index, the same cuvette is then measured for Yellowness Index (three measurements are recorded).
- Each cuvette is emptied and disposed.
- A new clean cuvette is used for each sample measured.
- All recorded data is then recorded into the corresponding Sample Trackers

Note that the instrument measurement capability is capped at 1000 APHA value.

[0040] Oxirane value (oxirane oxygen) is determined in accordance with ASTM D 165 and using the procedure provided below.

Titrando 888 Metrohm titrator with 801 stir unit and Tiamo 2.1 software is used for epoxy oxygen number analysis.

Sample size – 0.15g
Electrode – pH electrode
Dispensing unit - 0.1N Perchloric acid

Reagents:

- Dichloromethane
- 20 % tetraethyl ammonium bromide in acetic acid

Procedure:

0.15 g of sample weighed into a 100 ml beaker. Then 30ml of dichloromethane and 15 ml of 20 % tetraethyl ammonium bromide in acetic acid are added. Mix is titrated immediately. Oxirane value is calculated automatically by software.

[0041] Yellowness Index (YI) is measured in accordance with ASTM D 1925 (with cross reference to ASTM E 313). A MiniScan XE Colorimeter is used to measure YI with following conditions:

Standard:	Working
Display:	Absolute
Average:	Off
Illuminant/Observe:	D65°/10° (Standard observer)
Color Scale:	XYZ
Index:	YI

The colorimeter is calibrated using a white and black color standard tile. The colorimeter is held on the bench top stand and attached to the sample cup holder assembly. The stand is rotated so that the measurement port is facing up. The instrument settings are loaded in the analyzer according to the manufacturer's Instructions.

A 2.5 inch clean and dry glass sample cup is fitted with a 10 mm insert black ring so that it settles flat on the bottom of the cup. The ring fixes the internal path length of light through the aqueous sample at 10 mm and excludes ambient light that can cause measurement interference. The sample is gently stirred to ensure a homogeneous mixture. The glass sample cup is then filled with the plasticizer sample until the sample is above the level of the black ring. The white ceramic tile is pushed on the disk down through the liquid sample until it rests firmly on top of the black ring. The disk provides a white background to direct light that travels through the sample back to the detector. The filled sample cup is placed on the measurement port in the sample cup holder to center the cup over the port. The sample cup is covered with the opaque cover. The opaque cover prevents ambient light from outside the instrument from leaking into the detector.

[0042] Some embodiments of the present disclosure will now be described in detail in the following Examples.

EXAMPLES

1. Sample Preparation

[0043] Oven heat aging: Each plasticizer sample and polymeric composition sample is heated in a type II convection oven at 190°C. Samples are collected at various time intervals and are rested on a table top to cool. After 24 hours, APHA values and YI values are measured on each of these samples.

2. Polymeric compositions

[0044] Table 1 below shows polymeric compositions containing PVC and plasticizer.

Table 1—Polymeric Compositions

Name	Comparative Ex 1	Comparative Ex 2	Inventive Ex 1	Inventive Ex. 2
	ESO1 + Directly epoxidized eFAME	ESO2 + Directly epoxidized eFAME	ESO2 + TeFAME 1	ESO2 + TeFAME 2
Oxyvinyl 240 F (PVC)	74.85	74.85	74.85	74.85
ESO1 + Directly Epoxidized EFAME (50/50 blend)	25	0	0	0
ESO2 + Directly Epoxidized EFAME (50/50 blend)	0	25	0	0
TeFAME 1	0	0	12.5	0
ESO 2	0	0	12.5	12.5
TeFAME 2	0	0	0	12.5
Baeropan 9754 KA	0.15	0.15	0.15	0.15
Total	100	100	100	100

[0045] Table 2 shows Yellowness Index Values for polymeric compositions heat aged at 190°C for the designated time duration.

Table 2 – YI Values

Name	Time, min	YI, Avg	Std dev
Comparative Ex 1	0	8	0
Comparative Ex 1	5	22	3
Comparative Ex 1	10	37	1
Comparative Ex 1	20	133	0
Comparative Ex 1	30	152	0
Comparative Ex 1	40	187	0
Comparative Ex 2	0	8	0
Comparative Ex 2	5	23	1
Comparative Ex 2	10	39	1
Comparative Ex 2	20	128	2
Comparative Ex 2	30	142	1
Comparative Ex 2	40	172	1
Inventive Ex 1	0	7	0
Inventive Ex 1	5	11	0
Inventive Ex 1	10	23	0
Inventive Ex 1	20	89	0
Inventive Ex 1	30	90	1
Inventive Ex 1	40	163	0
Inventive Ex 2	0	6	0
Inventive Ex 2	5	12	0
Inventive Ex 2	10	24	0
Inventive Ex 2	20	94	1
Inventive Ex 2	30	124	0
Inventive Ex 2	40	138	2

[0046] Inventive examples 1 and 2 (IE1-2) contain PVC and eSO/TeFAME plasticizer. Comparative Examples 1 and 2 contain PVC, eSO and eFAME. The eFAME of Comparative Examples 1 and 2 is prepared by way of direct epoxidation. IE1 and IE2 unexpectedly have lower YI at 190°C/100min than Comparative Examples 1 and 2. Bounded by no particular theory, it is believed the lower YI at 190°C/100min for IE1 and IE2 is due to the stability of the TeFAME as compared to the less stable, direct epoxidized eFAME present in the comparative samples. It is believed the oxirane value of greater than 6.8% contributes to the unexpected stability of the present TeFAME, and resultant color retention of IE1 and IE2 when heat aged.

CLAIMS

1. A plasticizer comprising:

a blend of an epoxidized soybean oil and a trans-esterified epoxidized fatty acid methyl ester having an oxirane value greater than or equal to 6.8 %;

the plasticizer having an APHA value from 250 to 650 when heat aged at 190°C for 100 minutes.

2. The plasticizer of claim 1 comprising from 35 wt % to 65 wt % epoxidized soybean oil and from 65 wt % to 35 wt % trans-esterified epoxidized fatty acid methyl ester.

3. A polymeric composition comprising:

a vinyl chloride resin; and

the plasticizer of Claim 1.

4. The polymeric composition of claim 5 wherein the polymeric composition has a Yellowness Index less than 165 when heat aged at 190°C for 100 minutes.

5. The polymeric composition of claim 3 wherein the vinyl chloride resin is polyvinyl chloride.

6. A coated conductor comprising:

a conductor;

a coating on the conductor, the coating formed from the polymeric composition of Claim 3.

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. C08K5/1515 H01B3/44
ADD. C08K5/101 C08K5/103 C08L27/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C08K H01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	WO 2011/041363 A1 (DOW GLOBAL TECHNOLOGIES LLC [US]; CHAUDHARY BHARAT I [US]; SCHILLER KL) 7 April 2011 (2011-04-07) Comparative Example 3	1,3-5
L	"Vikoflex Products. Epoxidized soybean and linseed fatty acid esters", , 18 April 2009 (2009-04-18), pages 1-2, XP055008229, Retrieved from the Internet: URL:http://arkemaus.com/tds/1147.pdf [retrieved on 2011-09-27] Vikoflex 7010	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
6 December 2012	14/12/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rodríguez, Luis

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/055307

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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