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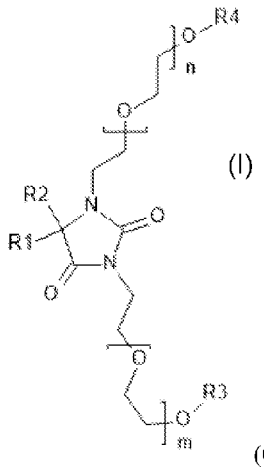
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(54) Title: OPEN TIME ADDITIVE

(57) Abstract: The present disclosure is generally directed to an architectural paint that includes an open time additive having the structure of Compound I, a salt thereof, or both. Compound I having the following formula (I): (Compound I).



(Compound I).

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OPEN TIME ADDITIVE

BACKGROUND

[0001] Paints are widely used across many industries and may generally be understood to encompass a carrier that includes a pigment. However, this general view neglects that paint, especially architectural paints, also provide a protective barrier or cover to surfaces. Architectural paints may benefit from improved workability (e.g., open time) where the paint has yet to dry and may be spread further (e.g., using a brush or roller). As such, paint compositions can vary widely depending on the application.

[0002] While open time can be defined in a number of ways, the term is generally used to indicate the time a paint film allows for smooth integration of subsequently applied paint and/or the time a coating remains workably wet before setting. As already discussed, open time can be an important aspect in characterizing paints since the open time can lead to reduced overlapping of coating defects, reduced labor costs, and/or reduced material costs for fixing defects.

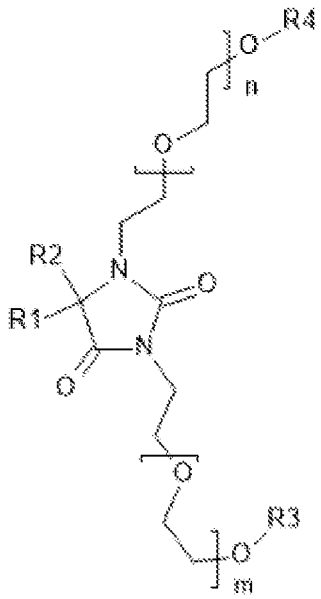
[0003] Some known options for adjusting open time can include increasing water content, using glycol or glycerol esters, or using additives that can increase costs significantly. Most of these solutions may only provide low/marginal open time extension and can have deleterious effects on other aspects of the paint performance. Depending on region, the known options could also be listed as a volatile organic compound (VOC), which is under much global scrutiny.

[0004] Allowing for sufficient time to paint, repair, or cover architectural coatings continues to be a challenge, especially in dry environments. Additionally, paints that have a low pigment volume concentration (PVC), such as a high solid content, and regions with strict VOC regulations can compound the challenge.

[0005] Needed still in the art are architectural paints that include an open time additive in an effective amount to maintain workability under various conditions. Additionally, due to variations in environmental conditions (e.g., humidity), paints that include an open time additive that can be modified to adjust the workability may provide additional benefits for manufacturers and consumers. For instance, customizing paint formulations by adjusting the open time additive may lead to cost savings, especially in large construction projects.

SUMMARY

[0006] In general, the present disclosure is directed to an architectural paint composition that includes an open time additive. Architectural paints may be considered as different from other paints, dyes or compositions including pigments in that architectural paints can provide a coating for covering a surface and/or a material. Thus, generally, architectural paints can be used without the architectural paints modifying the surface and/or the material to which they are applied. In contrast, dyes or other pigment compositions may be used to incorporate the dye or a portion of the dye (e.g., the pigment/colorant) into the material. Due at least in part to these differences, architectural paints may benefit from additives that can act to increase the open time of the architectural paint. In contrast, increasing the open time of dyes or other pigment compositions could lead to undesirable bleeding. Example implementations of the present disclosure can include architectural paint compositions that include at least one open time additive having the formula of Compound I:



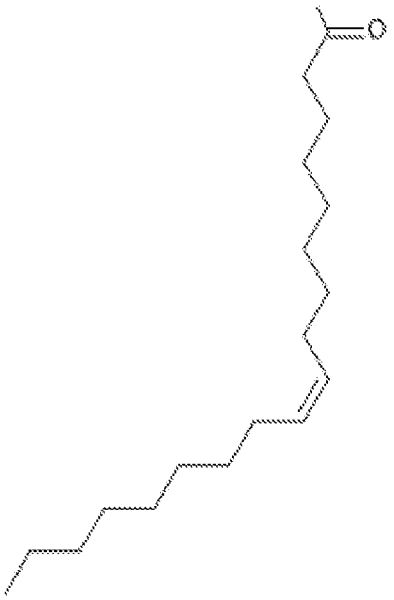
(Compound I),

[0007] wherein m is an integer no less than zero (0) and no greater than one hundred (100), n is an integer no less than zero (0) and no greater than one hundred (100), and R1 and R2 are independently a branched or linear carbon chain having no less than one (1) and no more than forty (40) carbon atoms,

[0008] wherein each carbon atom in R1 and R2 is independently substituted with one or more hydrogen atom, one or more hydroxyl group, one or more other carbon atom in the branched or linear carbon chain, an aryl group, or a combination thereof, and

[0009] wherein each of R3 and R4 are independently a hydrogen atom or an ester group, such as an oleate group.

[0010] In a first example aspect, the oleate group may have the formula of:



(oleate group).

[0011] In a second example aspect, the latex binder may include an acrylate.

[0012] In a third example aspect, the solvent may be water.

[0013] In a fourth example aspect, a concentration of the open time additive in the architectural paint composition may be no less than about a tenth of a percent and no greater than about five percent based on the total weight of the architectural paint composition.

[0014] In a fifth example aspect, m may be an integer no less than five and no greater than one hundred.

[0015] In a sixth example aspect, n may be zero.

[0016] In a sixth example aspect, n may be no greater than ten, and m may be no greater than ten.

[0017] In a sixth example aspect, R3, R4, or both may be the ester group, such as the oleate group.

[0018] In a sixth example aspect, the architectural paint may have a solids content no less than about ten percent and no greater than about seventy percent based on the total weight of the architectural paint composition.

[0019] In a seventh example aspect, the open time additive and the latex binder may have a weight ratio of 1:999 to about 100:900 based on the total weight of the open time additive to the total weight of the latex binder.

[0020] In an eighth example aspect, R1 and R2 may both be methyl groups.

[0021] In a ninth example aspect, the architectural paint may display an increased open time of no less than ten percent compared to a baseline open time displayed for a baseline architectural paint.

[0022] In a tenth example aspect, the baseline architectural paint may not include the open time additive and has a relative composition for other components included in the architectural paint that is approximately the same, and the open time may be determined according to OTA test ASTM D7488-11 "Standard Test Method for Open Time of Latex Paints".

[0023] In an eleventh example aspect, the architectural paint may have a volatile organic compound, VOC, content of less than one thousandth of a percent based on the total weight of the architectural paint, and the VOC content may be determined according to EPA Method 24.

[0024] A twelfth example aspect of the present disclosure can include a method for modifying the open time of an architectural paint by forming an aqueous latex paint with an open time additive having the structure of Compound I.

[0025] Each of the example aspects recited above may be combined with one or more of the other example aspects recited above in certain embodiments. For instance, all of the twelve example aspects recited above may be combined with one another in some embodiments. As another example, any combination of two, three, four, five, or more of the twelve example aspects recited above may be combined in other embodiments. Thus, the example aspects recited above may be utilized in combination with one another in some example embodiments. Alternatively, the example aspects recited above may be individually implemented in other example embodiments. Accordingly, it will be understood that various example embodiments may be realized utilizing the example aspects recited above.

[0026] Other features and aspects of the present disclosure are discussed in greater detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] A full and enabling description of the present disclosure is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

[0028] FIG. 1 depicts a photograph of paint applied to a surface that illustrates example attributes of the paint such as wet edge lines and open time.

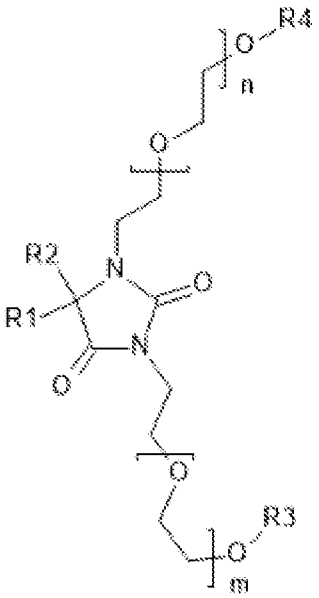
[0029] FIG. 2 depicts example photographs of paint coatings after applying an abrasive force that illustrates example attributes of the paint such as scrub resistance.

[0030] Repeat use of reference characters in the present specification and drawings is intended to represent the same or analogous features or elements of the present invention.

DETAILED DESCRIPTION

[0031] It is to be understood by one of ordinary skill in the art that the present disclosure is a description of exemplary embodiments only and is not intended as limiting the broader aspects of the present disclosure.

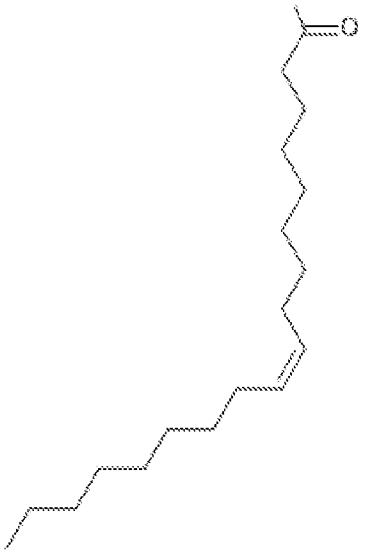
[0032] The present disclosure is generally directed to an architectural paint that includes an open time additive having the structure of Compound I, a salt thereof, or both. Compound I has the following formula:



(Compound I),

[0033] wherein m is an integer no less than zero (0) and no greater than one hundred (100), n is an integer no less than zero (0) and no greater than one hundred (100), and R1 and R2 are independently a branched or linear carbon chain having no less than one (1) and no more than forty (40) carbon atoms, wherein each carbon atom in R1 and R2 is independently substituted with one or more hydrogen atom, one or more hydroxyl group, one or more other carbon atom in the branched or linear carbon chain, an aryl group, or a combination thereof, and wherein each of R3 and R4 are independently a hydrogen atom or an ester group.

[0034] The ester group may be an oleate group having the following formula:



(oleate group).

In certain example embodiments, the ester group may be a saturated or unsaturated C6 to C22 ester group, such as stearate (C18, saturated), oleate (C18, unsaturated), linoleate (C18, unsaturated), palmitate (C16, saturated), laurate (C12 saturated), decanoate (C10, saturated), or octanoate (C8, saturated).

[0035] In one example implementation, the architectural paint includes a solvent, a latex binder (e.g., a polymer including one or more acrylate, vinyl acetate, vinyl chloride, and/or styrene butadiene monomers), and the open time additive. Optionally, the architectural paint can further include a dispersant and/or surfactant to improve distribution of the latex binder throughout the architectural paint. In this manner, the dispersant and/or surfactant can be used to produce a more homogenous mixture that can provide a more even coating of the architectural paint. Optionally, the architectural paint can include a thickening agent to adjust the viscosity of

the architectural paint to improve adhesion of the wet paint to an applicator (e.g., a brush or roller). Optionally, the architectural paint can include one or more pigments (e.g., TiO_2) for providing a color to the architectural paint. Optionally, the architectural paint can include a cosolvent (e.g., ethylene glycol) that can improve solubility of components of the architectural paint.

[0036] An example aspect of implementations according to the present disclosure can include a low volatile organic compounds (VOCs) content. High VOCs are recognized as environmental hazards as well as demonstrating personal hazards to painters who work in confined and/or unventilated spaces. In these spaces, VOCs can collect in the air which may cause breathing issues for painters and possible health concerns. Many known paint additives that are used to modify the paint open time are known high VOCs which has posed challenges. Poor open time performance can require increased working time to correct mistakes, such as streaking that are inherent to the paint composition. Thus, improving open time while also mitigating VOC content can provide a great advantage in the cost and efficiency of paint projects as well as the health of painters.

[0037] Another aspect of example implementations can include a type of latex binder. The latex binder can include various polymers suitable for architectural paints such as an acrylates (e.g., polymethylmethacrylate), that can be formed as a homopolymer or co-polymer. For example, a co-polymer can include incorporation of another monomer (e.g., butadiene styrene). In some implementations, the acrylate can be modified to include one or more nitrile groups. Thus, latex binders can include various acrylates, acrylate butadiene styrene copolymers, and acrylonitrile butadiene styrene copolymers. Additionally, these latex binders are provided for example purposes, and additional latex binders may be used alone or in combination with implementations of the disclosure.

[0038] As an example for illustration, an implementation of the present disclosure can include an architectural paint including a latex binder with an acrylate. The acrylate can include a polymer or copolymer that includes one or more acrylate monomers. Example aspects of the acrylate polymer or copolymer can include a mass fraction of an acrylate monomer. For instance, the acrylate can include a copolymer that includes an acrylate monomer (e.g., methyl methacrylate) and a second monomer (e.g., butadiene styrene). The mass fraction of the acrylate monomer to the total weight of the copolymer can define the mass fraction. In some acrylates the

mass fraction of acrylate monomer to the total weight of the copolymer can be no less than about twenty (20) wt% and no greater than about one hundred (100) wt% such as no less than about thirty (30) wt% and no greater than about eighty (80) wt%, no less than about forty (40) wt% and no greater than about seventy (70) wt%, or no less than about forty five (45) wt% and no greater than about sixty (60) wt% (e.g., one hundred (100) wt%, ninety five (95) wt%, ninety (90) wt%, eighty five (85) wt%, eighty (80) wt%, seventy five (75) wt%, seventy (70) wt%, sixty five (65) wt%, sixty (60) wt%, fifty five (55) wt%, or fifty (50) wt%). In particular, certain implementations can include an acrylate having a mass fraction of acrylate monomer to the total weight of acrylate greater than fifty (50) wt%.

[0039] For certain example implementations of the present disclosure, the open time additive can include one or more of 1,3-Bis(2-(hydroxypolyethoxy)ethyl)-5,5-dimethylimidazolidine-2,4-dione, 1,3-Bis(2-(hydroxypolyethoxy)ethyl)-5,5-dimethylimidzaolidine-2,4-dione monoester, and 1,3-Bis(2-(hydroxypolyethoxy)ethyl)-5,5-dimethylimidzaolidine-2,4-dione diester. Each of these compounds can be derived from the formula of Compound I, respectively, as follows: n is no less than one (1) and no greater than one hundred (100) and m is no less than one (1) and no greater than one hundred (100), R1 and R2 are each linear carbon chains including one (1) carbon atom substituted with three (3) hydrogen atoms (e.g., a methyl group); R1 and R2 are each linear carbon chains including one (1) carbon atom substituted with three (3) hydrogen atoms (e.g., a methyl group) and R4 or R3 is an ester group; and R1 and R2 are each linear carbon chains including one (1) carbon atom substituted with three (3) hydrogen atoms (e.g., a methyl group) and both R4 and R3 are an ester group.

[0040] In implementations where the open time additive includes the oleate group, it should be understood that the oleate group is bound such that the carbonyl carbon is linked to the terminal oxygen (at R3 and/or R4) to form an ester. Thus, the oleate group is illustrated to display the fatty acid carbon chain (seventeen (17) carbon, mono-unsaturated group) bound to the carbonyl carbon and a second bond to indicate the attachment position of Compound I to the oleate group.

[0041] Further, in implementations of the present disclosure, it should be understood that for open time additives based on Compound I, the polymerization degrees n and m can be different (e.g., n and m may have different values such as n is four and m is five) or the same (e.g., n is four and m is four). Additionally, certain implementations may include combinations of open

time additives based on Compound I such as an architectural paint including both 1,3-Bis(2-(hydroxypolyethoxy)ethyl)-5,5-dimethylimidazolidine-2,4-dione and 1,3-Bis(2-(hydroxypolyethoxy)ethyl)-5,5-dimethylimidzaolidine-2,4-dione monooleate.

[0042] Example implementations formulated according to the present disclosure may provide additional benefits for formulating low VOC architectural paints. In particular, example implementations may include a solvent that can be considered low or no VOC. For instance, water is not an organic compound and so is preferably incorporated in architectural paints of the present disclosure. In addition to water, a co-solvent can be included to improve solubility of components of the architectural paint (e.g., the open time additive, surfactants, pigments, etc.). Example co-solvents may be VOC exempt (e.g., acetone, dimethyl carbonate, methyl acetate, parachlorobenzotrifluoride, tert-butyl acetate, and propylene carbonate) or be included in lower concentrations (e.g., lower weight percentages) to limit the VOC concentration of the architectural paint.

[0043] For instance, certain implementations of the present disclosure can include architectural paints having a VOC content of less than one thousandth of a percent (<0.001%) based on the total weight of the architectural paint. VOC content can be determined using various methods, preferably example implementations can include specific VOC content determined according to EPA Method 24 for surface coatings.

[0044] Alternative methods for determining VOC content may also be used to determine VOC content in some example implementations. For instance, ASTM D6886-14 does not specifically define what constitutes a VOC ingredient based on chemical properties, but rather, implies that any components that produce a peak in a gas chromatogram are considered VOC (exempt or non-exempt). Additionally, IOS 11890-2 can be used to determine VOC content based on a pre-defined boiling point limit. As an example, if the term "VOC" is being used for compounds whose boiling points are below the boiling point limit, a marker compound of known purity and with a boiling point (BP) within ±3°C of the defined maximum is used. So, if the EU definition for VOC is being employed (i.e. any compound with a boiling point below 250 °C is classified as VOC), tetradecane (with a BP of 252.6 °C) or a similar boiling point non-polar compound can be used as a marker compound for non-polar systems, while diethyl adipate (with a BP of 251°C) can be used for polar systems,

[0045] Example implementations in accordance with the present disclosure may include a VOC content, as determined using one of the methods disclosed herein (e.g., EPA Method 24), of no less than one hundred thousandth of a percent (0.00001%) and no greater than one thousandths of a percent (0.001%), such as a VOC content no less than five hundred thousandths of a percent (0.00005%) and no greater than eight ten thousandths of a percent (0.0008%), or no less than on ten thousandth of a percent (0.0001%) and no greater than five ten thousandths of a percent (0.0005%). In some implementations, the VOC content can be substantially zero, for example including a substantially undetectable amount of VOC based on the analytical tool used to determine VOC content (e.g., a gas chromatograph).

[0046] For example implementations, the open time additive can be included in the architectural paint in an effective amount to produce reduced streaking, even in environments that have low humidity. For instance, the open time additive can be included at a concentration of no less than about one tenth of a percent (0.1%) and no greater than about five percent (5%) based the weight of the open time additive to the total weight of the architectural paint, such as no less than about one half percent (0.5%) and no greater than about four and one half percent (4.5%), no less than about one percent (1.0%) and no greater than about four percent (4.0%), no less than about one and two tenths of a percent (1.2%) and no greater than about three and one half percent (3.5%), and no less than about two percent (2%) and no greater than about three percent (3%).

[0047] Example aspects of the open time additive can include substructures of Compound I. Some example substructures can include compounds where m is no less than five (5) and no greater than one hundred (100). Another example substructure can include compounds where n is zero (0). Additional example substructures can include compounds where n is no greater than ten (10) and m is no greater than ten (10). Additionally or alternatively, further example substructures can include compounds where R3 and/or R4 are an oleate group.

[0048] Another aspect of some implementations according to the present disclosure can include a solids content no less than five percent (5%) and no greater than seventy percent (70%), such as no less than eight percent (8%) and no greater than fifty percent (50%) or no less than ten percent (10%) and no greater than thirty percent (30%) [e.g., twelve percent (12%), fourteen percent (14%), fifteen percent (15%), sixteen percent (16%), or eighteen percent (18%)] based on the total weight of the open time additive to the total weight of the latex binder.

[0049] Aspects of some implementations of the present disclosure can include a weight ratio of the open time additive to the latex binder. Advantageously, the weight ratio of the open time additive to the latex binder is no greater than 1:999 and no less than 1:9 such as no greater than 1:900 and no less than 1:9, no greater than 1:800 and no less than 1:9, no greater than 1:800 and no less than 1:90, or no greater than 1:800 and no less than 1:200 (e.g., 1:900, 1:800: 1:700 1:600, 1:500, 1:400, 1:300, 1:200, or 1:100).

[0050] As used herein, the weight ratio of the open time additive to the latex binder should be understood on the basis of the open time additive. As such, no greater than 1:999 should be read as for every one (1) weight unit of the open time additive, there is no greater than nine-hundred and ninety-nine (999) weight units of the latex binder. As another example for illustration, no less than 1:9 should be read as for every one (1) weight unit of the open time additive, there is no less than nine (9) weight units of the latex binder.

[0051] In implementations of the present disclosure, the architectural paint can include or may be formulated to include an amount of pigment. For instance, certain example architectural paints can include a pigment, the pigment including titanium dioxide (TiO_2) at a concentration of no less than fifteen (15) wt% TiO_2 and no greater than sixty (60) wt% TiO_2 based on the total weight of the architectural paint. TiO_2 can be used to impart whiteness and/or opacity to example implementations and may also be included to build viscosity. In general, example implementations can include no less than fifteen (15) wt% and no greater than sixty (60) wt% TiO_2 such as no less than eighteen (18) wt% and no greater than fifty five (55) wt% TiO_2, no less than twenty (20) wt% and no greater than fifty (50) wt% TiO_2, or no less than twenty five (25) wt% and no greater than forty five (45) wt% TiO_2.

[0052] One example aspect of certain implementations can include an increase in open time resulting from the addition of the open time additive to the paint composition. To determine the increase in open time, a base paint having a composition that does not include the open time additive can be modified to produce the architectural paint, by adding an effective amount of the open time additive to the base paint. For some implementations, the addition of the effective amount of the open time additive to the base paint can produce an increase in the open time determined for the architectural paint, relative to the base paint alone, of no less than ten percent (10%), such as no less than twenty percent (20%). Open time can be determined using a variety of methods, preferably implementations according to the present disclosure can determine open

time according to OTA test ASTM D7488-11 “Standard Test Method for Open Time of Latex Paints”.

[0053] Alternatively or additionally, another example aspect of certain implementations can include an increase in scrub resistance resulting from the addition of the open time additive to the paint composition. To determine the increase in scrub resistance, a testing method such as ASTM D 2486 can be used to compare number of scrubs to failure and/or exposure of a substrate material after a number of scrubs. For instance, a first coating can be applied to the substrate material using a base paint and a second coating applied to the substrate material using an architectural paint, the architectural paint having been formulated by adding an effective amount of the open time additive to the base paint. After applying an abrasive force (e.g., a scrub) to the coatings, the scrub resistance can be determined based at least in part on removal of the coating and/or exposure of the substrate material. In some implementations, addition of an effective amount of the open time additive can produce an increase in scrub resistance (relative to the base paint) of no less than a quarter of a percent (0.25%) and no greater than sixty percent (60%), such as no less than ten percent (10%) and no greater than fifty percent (50%), no less than twelve percent (12%) and no greater than forty (40%), or no less than fifteen (15%) and no greater than thirty (30%).

[0054] Implementations of the present disclosure can also include methods for adjusting the open time of a base paint (e.g., an aqueous latex paint). The method may include forming an aqueous latex paint (e.g., a water-based acrylate) with an open time additive having the structure of Compound I or a substructure of Compound I as described herein.

[0055] One example aspect forming the aqueous latex paint with the open time additive can include homogenizing the aqueous latex paint while adding the open time additive. Homogenizing can include various forms of mixing to facilitate incorporation of the open time additive with the aqueous latex paint. For instance, homogenizing can include mixing at a specified rotation per minute (RPM) the aqueous latex paint, sonicating the aqueous latex paint at a specified frequency, and/or vortexing the aqueous latex paint. In this manner, the open time additive can be incorporated throughout the aqueous latex paint to produce an architectural paint according to example implementations of the present disclosure. Thus, example implementations can further include methods for producing architectural paints, such as example architectural paints of the disclosure using example methods of the disclosure.

[0056] Another aspect of methods for producing an architectural paint can include determining a solids content for the base paint (e.g., the aqueous latex paint), and, based at least in part on the solids content, adding an amount of Compound I to the base paint. In particular, the solids content can determine a basis for including an effective amount of the open time additive. For instance, the amount of latex binder can be determined based on the solids content and an effective amount of the open time additive can be determined according to the ratio of the open time additive to the latex binder disclosed in example implementations herein.

[0057] Certain methods for producing an architectural paint according to the present disclosure can further include modifying Compound I by adjusting the extent of polymerization (e.g., by selecting m and/or n) to modify the open time of the aqueous latex paint.

[0058] The preceding description is exemplary in nature and is not intended to limit the scope, applicability or configuration of the disclosure in any way. Various changes to the described embodiments may be made in the function and arrangement of the elements described herein without departing from the scope of the disclosure.

[0059] As used in this application and in the claims, the singular forms "a," "an," and "the" include the plural forms unless the context clearly dictates otherwise. Additionally, the term "includes" means "comprises." The methods and compositions of the present disclosure, including components thereof, can comprise, consist of, or consist essentially of the essential elements and limitations of the embodiments described herein, as well as any additional or optional ingredients, components or limitations described herein or otherwise useful in nutritional compositions.

[0060] Unless otherwise indicated, all numbers expressing quantities of ingredients, properties such as molecular weight, percentages, and so forth, as used in the specification or claims are to be understood as being modified by the term "about." Accordingly, unless otherwise indicated, implicitly or explicitly, the numerical parameters set forth are approximations that may depend on the desired properties sought and/or limits of detection under standard test conditions/methods. When directly and explicitly distinguishing embodiments from discussed prior art, the embodiment numbers are not approximates unless the word "about" is recited.

[0061] As used herein, "optional" or "optionally" means that the subsequently described material, event or circumstance may or may not be present or occur, and that the description

includes instances where the material, event or circumstance is present or occurs and instances in which it does not. As used herein, "wt%" and " w/w%" means by weight as a percentage of the total weight or relative to another component in the composition.

[0062] The term "about" is intended to mean approximately, in the region of, roughly, or around. When the term "about" is used in conjunction with a numerical range, it modifies that range by extending the boundaries above and below the numerical values set forth. Unless otherwise indicated, it should be understood that the numerical parameters set forth in the following specification and attached claims are approximations. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, numerical parameters should be read in light of the number of reported significant digits and the application of ordinary rounding techniques.

[0063] The phrase “effective amount” means an amount of a compound that promotes, improves, stimulates, or encourages a response to the particular condition or disorder or the particular symptom of the condition or disorder.

[0064] The present disclosure may be better understood with reference to the following example.

Example

[0065] Various formulations were made in accordance with the present disclosure and tested for wet edge to open time ratio (WE/OT); open time (OT), and dry to touch (DTT). A standard paint with a forty percent (40%) pigment volume concentration (PVC) solids was used for the comparative test. To the blank paint, a two percent (2%) amount of an open time additive according to the present disclosure (DS 7034, DS 7035, or DS 7036) or a commercial additive (Optifilm OT-1200 or Rhodoline OTE-600) was incorporated. Each of these formulations was characterized using OTA test ASTM D7488-11 “Standard Test Method for Open Time of Latex Paints” and the collected results are shown in Table 1. DS 7034 was an open time additive according to the present disclosure with a long chain ester, namely an oleate group; DS 7035 was an open time additive according to the present disclosure with an unsubstituted, short chain ester, namely R3 and R4 are hydrogens and n and m are zero (0); and DS 7036 was an open time additive according to the present disclosure with an intermediate chain ester, namely shorter than the oleate group of DS 7034. Optifilm OT-1200 was a proprietary mixture believed to be styrene-modified acrylic resin containing the methacrylate DHDM combined with 1,4-

cyclohexanedimethanol and ammonium hydroxide, and Rhodoline OTE-600 was a proprietary blend believed to be a polyalkaline glycol species.

[0066] Table 1. Open time and dry-to-touch measurements of paints treated with open time additives compared to commercial products.

Sample ID	**Wet film WE/OT, min.**	**OT (dry film), min.**	**DTT Time , min.**
Blank 40 PVC Int Paint, batch RD0278-106	≤ 2 / 6	6	35
Blank paint + 2% DS 7034	< 4 / 10	10	55
Blank paint + 2% DS 7035	2 / 14	10	35
Blank paint + 2% DS 7036	≤ 2 / 14	10	45
Blank paint + 2% Optifilm OT-1200	< 4 / 10	8	45
Blank paint + 2% Rhodoline OTE-600	6 / 10	10	40

[0067] FIG. 1 provides a photograph of an example process for determining wet edge and open time. As depicted, wet edge lines can be visually identified near the edge of the paint surface, and values determined based at least in part on reapplication time subtracted from the time the edge of paint can no longer be worked into body of paint. Additionally, open time can be visually identified by streaking, and values determined based on repair time subtracted from the time X is visible after a paint cycle. Physical characteristics of the open time additives used to modify the standard paint time as well as the effect of the open time additives are provided in Table 2. As shown, all of the open time additives according to example aspects of the present disclosure extended the open time by about two (2) minutes to about four (4) minutes compared to the standard paint.

[0068] Table 2. Properties of open time additives used for comparative studies.

Material	**DS7034**	**DS 7035**	**DS 7036**	**Optifilm OT-1200**	**Rhodoline OTE-600**
% Assay	100	90	75	< 69	100
Open Time Ext.	60% (+4 min)	60% (+4 min)	60% (+4 min)	30% (+2 min)	60% (+4 min)

Thermal Profile		BP > 400C	BP 239-254C	Decomp. 213C	NK	BP 284C*
VOC Implication	*US*	No VOC	Low/No VOC	Low/ No VOC	Low/No VOC	Low/No VOC
	EU	No VOC	Low/No VOC	Low/No VOC	Low/No VOC	Low/No VOC
Commercial		Yes	Yes	No	Yes	Not in US
Registration	*US*	Yes	Yes	Yes	Yes	Yes
	EU	Yes	Yes	No	Yes	Yes

[0069] To determine VOC content, for example as provided in Table 2, example methods ISO 11890-2, ASTM D6886-14 and EPA Method 24 were performed to compare the results of each method on example open time additives (OTA) DS 7034, DS 7035, and DS 7036. The results are collected in Table 3, which also includes thermal properties such as melting point and boiling point. The boiling point was determined based on the onset temperatures of the large endothermic event observed using dynamic scanning calorimetry (DSC) analysis and the significant weight loss that occurred in the thermogravimetric analysis (TGA) scans. For EPA Method 24, criteria for VOC was based on weight loss (corrected for water content) after 1 hour in a 110 ℃ oven.

Table 3. VOC content determined using different methods for example open time additives.

	Thermal Analysis Results		**Contributes to VOC per ISO 11890-2**	**Contributes to VOC per ASTM D6886-14**	**VOC Content**
Example OTA	Melting Point (MP), ℃	Boiling Point (BP), ℃	VOC has BP ≥ 250 ℃	VOC indicated by peak on Chromatogram	EPA Method 24
DS 7034	< 25	≥ 400	No	No	No VOC
DS 7035	< 25	~250	No	Yes	Low/No VOC

DS 7036	71	~213	No*	Yes	Low/NO VOC

* - DS 7036 decomposes at 213° C, which is considered "No" VOC herein.

[0070] Example open time additives were also tested to determine the impact of the open time additives on scrub resistance. To determine scrub resistance, a standard method, ASTM D 2486, was used to determine the increase in scrub resistance with respect to a blank paint (i.e., a paint not including the open time additive). Unexpectedly, the open time additives were found to produce an increase in scrub resistance (e.g., removal of the architectural paint from a surface). To understand the impact of the open time additives, three different commercial paints (high premium, mid-premium, and low-premium) were tested. A blank sample including only the commercial paint and a test sample including two percent (2%) of open time additive DS 7034 were compared using a freshly formulated paint or paint stored at fifty (50) °C for eight (8) days. Example results are presented in Table 4, which demonstrates increases in scrub resistant with respect to the blank paint.

[0071] Table 4. Scrub resistance data for commercial paints including 2% DS 7034.

Storage Conditions	% increase in Scrub Resistance with Respect to Blank Paint		
	Commercial Paint A	Commercial Paint B	Commercial Paint C
Fresh Paint	48.96%	46.92%	17.22%
Paint stored at 50 °C for 8 days	19.21%	21.88%	14.09%

[0072] FIG. 2 provides six photographs depicting example scrub resistance data determined using ASTM D 2486. A coating of blank paint or the paint including two percent (2%) of an open time additive (e.g., DS 7034) was applied to a dark substrate. After applying a similar abrasive process to each coating, loss of paint was determined based on the appearance of the substrate. Testing was performed for both freshly formulated paint (fresh paint) and formulated paint that was stored at 50 °C for 8 days.

[0073] Example data further demonstrating scrub resistance is provided in Table 5 which includes the number of scrubs applied to both the blank paint (Blank) coating and the paint including two percent (2%) of the open time additive (2% DS 7034) to reach failure. Two

separate trials were conducted (Trial 1 and Trial 2) for each coating to determine an average increase relative to the Blank.

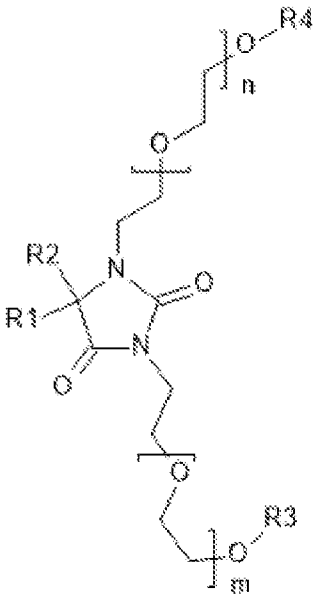
[0074] Table 5. Trial data for determining scrub resistance.

	Paint	No. of Scrubs		% Increase Scrub Resistance	Avg. % increase
		Blank	2% DS 7034		
Fresh	Paint A – Trial 1	1074	1698	58.1	48.97
	Paint A – Trial 2	1052	1471	39.83	
Stored	Paint A – Trial 1	1119	1134	19.21	19.21
	Paint A – Trial 2	NT	NT	NT	
Fresh	Paint B – Trial 1	1031	1538	49.18	46.92
	Paint B – Trial 2	965	1396	44.66	
Stored	Paint B – Trial 1	1249	1253	0.32	21.88
	Paint B – Trial 2	1082	1552	43.44	
Fresh	Paint C – Trial 1	702	874	25.5	17.72
	Paint C – Trial 2	604	664	9.93	
Stored	Paint C	809	923	14.09	14.09
	Paint C	NT	NT	NT	

[0075] These and other modifications and variations to the present disclosure may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention, which is more particularly set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only and is not intended to limit the invention so further described in such appended claims.

What Is Claimed:

1. An architectural paint composition, comprising:
a solvent;
a latex binder; and
an open time additive having the structure of Compound I, a salt thereof, or both,
wherein Compound I has the following formula:



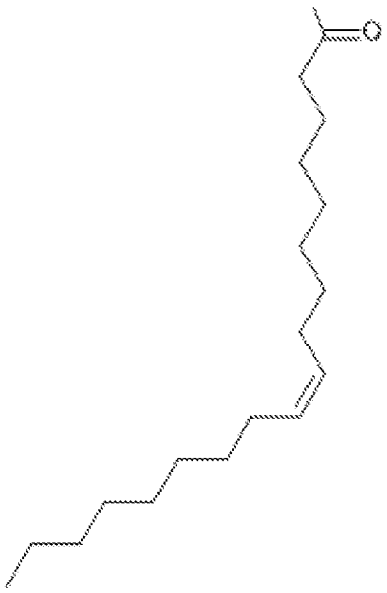
(Compound I),

wherein m is an integer no less than zero and no greater than one hundred, n is an integer no less than zero and no greater than one hundred, and R1 and R2 are independently a branched or linear carbon chain having no less than one and no more than forty carbon atoms,

wherein each carbon atom in R1 and R2 is independently substituted with one or more hydrogen atom, one or more hydroxyl group, one or more other carbon atom in the branched or linear carbon chain, an aryl group, or a combination thereof, and

wherein each of R3 and R4 are independently a hydrogen atom or an ester group.

2. The architectural paint composition of claim 1, wherein the ester group is an oleate group having the following formula:



(oleate group).

3. The architectural paint composition of either claim 1 or claim 2, wherein the latex binder comprises an acrylate.

4. The architectural paint composition of any one of the above claims, wherein the solvent is water.

5. The architectural paint composition of any one of the above claims, wherein a concentration of the open time additive in the architectural paint composition is no less than about a tenth of a percent and no greater than about five percent based on the total weight of the architectural paint composition.

6. The architectural paint composition of any one of the above claims, wherein m is an integer no less than five and no greater than one hundred.

7. The architectural paint composition of any one of the above claims, wherein n is zero.

8. The architectural paint composition of any one of the above claims, wherein n is no greater than ten, and m is no greater than ten.

9. The architectural paint composition of any one of the above claims, wherein R3, R4, or both is the oleate group.

10. The architectural paint composition of any one of the above claims, wherein

the architectural paint composition has a solids content no less than about ten percent and no greater than about seventy percent based on the total weight of the architectural paint composition.

11. The architectural paint composition of any one of the above claims, wherein the open time additive and the latex binder have a weight ratio of 1:999 to about 100:900 based on the total weight of the open time additive to the total weight of the latex binder.

12. The architectural paint composition of any one of the above claims, wherein R1 and R2 are both methyl groups.

13. The architectural paint composition of any one of the above claims, wherein the architectural paint composition displays an open time of no less than ten percent compared to a baseline open time displayed for a baseline architectural paint, and

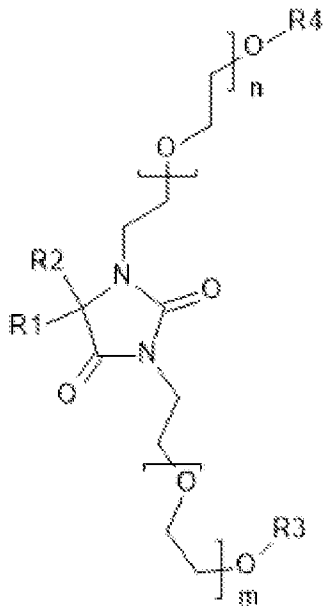
wherein the baseline architectural paint does not include the open time additive and has a relative composition for other components included in the architectural paint composition that is approximately the same, and wherein the open time is determined according to OTA test ASTM D7488-11 “Standard Test Method for Open Time of Latex Paints”.

14. The architectural paint composition of any one of the above claims, wherein the architectural paint composition has a volatile organic compound, VOC, content of less than one thousandth of a percent based on the total weight of the architectural paint composition, and wherein VOC content is determined according to EPA Method 24.

15. A method for increasing an open time of an aqueous latex paint, the method comprising:

forming the aqueous latex paint with an open time additive, wherein the open time additive has the structure of Compound I, a salt thereof, or both,

wherein Compound I has the following formula:



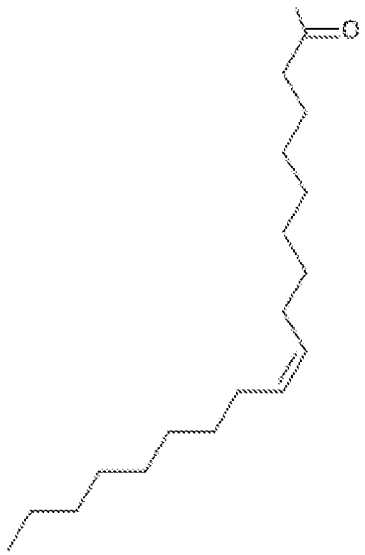
(Compound I),

wherein m is an integer no less than zero and no greater than one hundred, n is an integer no less than zero and no greater than one hundred, and R1 and R2 are independently a branched or linear carbon chain having no less than one and no more than forty carbon atoms,

wherein each carbon atom in R1 and R2 is independently substituted with one or more hydrogen atom, one or more hydroxyl group, one or more other carbon atom in the branched or linear carbon chain, an aryl group, or a combination thereof, and

wherein each of R3 and R4 are independently a hydrogen atom or an ester group.

16. The method of claim 15, wherein the ester group is an oleate group having the following formula:



(oleate group).

17. The method of either claim 15 or claim 16, wherein forming the aqueous latex paint with the open time additive comprises homogenizing the aqueous latex paint while adding the open time additive.

18. The method of any one of claims 15 through 17, further comprising:

determining a solids content for the aqueous latex paint, and wherein forming the aqueous latex paint with the open time additive comprises adding an amount of Compound I based at least in part on the determined solids content.

19. The method of any one of claims 15 through 18, wherein m is no less than five and no greater than one hundred.

20. The method of any one of claims 15 through 19, wherein n is zero.

21. The method of any one of claims 15 through 20, wherein n is no greater than ten, and m is no greater than ten.

22. The method of any one of claims 15 through 21, wherein R3, R4, or both is the oleate group.

23. The method of any one of claims 15 through 22, further comprising selecting m, n, or both to adjust the open time for the aqueous latex paint.

24. An aqueous latex paint made according to the method of any one of claims 15 through 23.

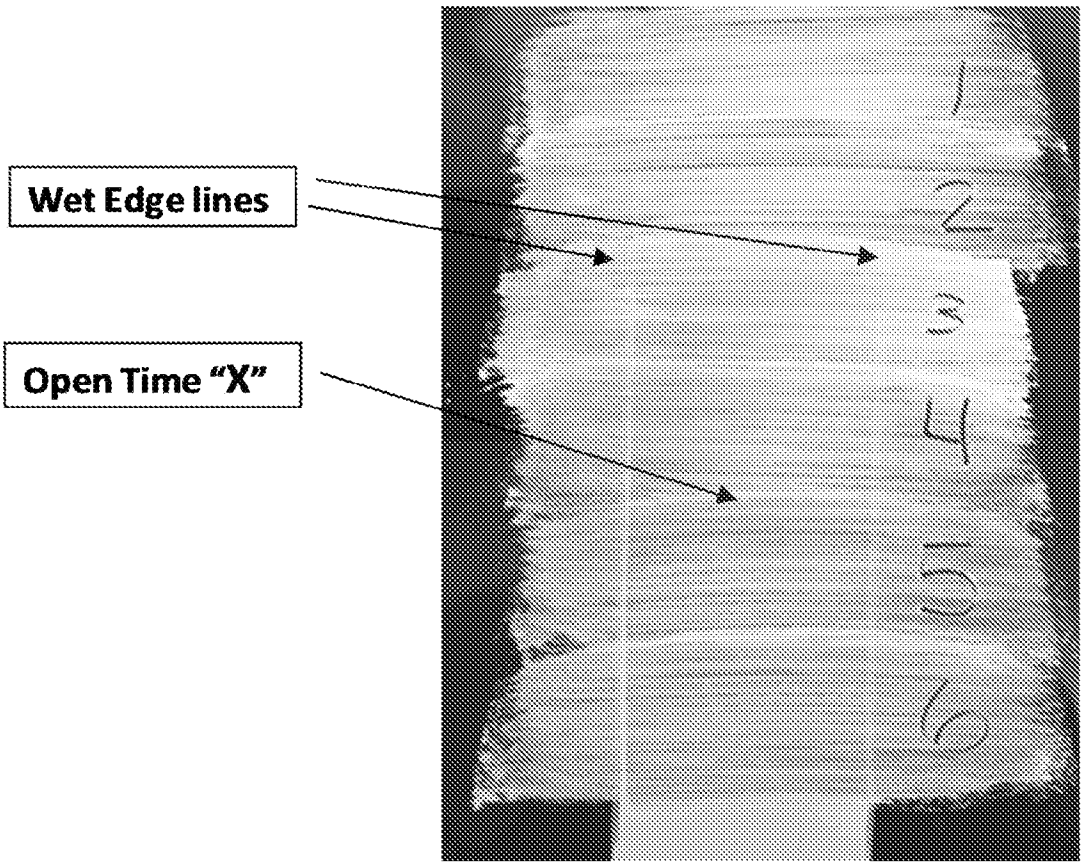


FIG. 1

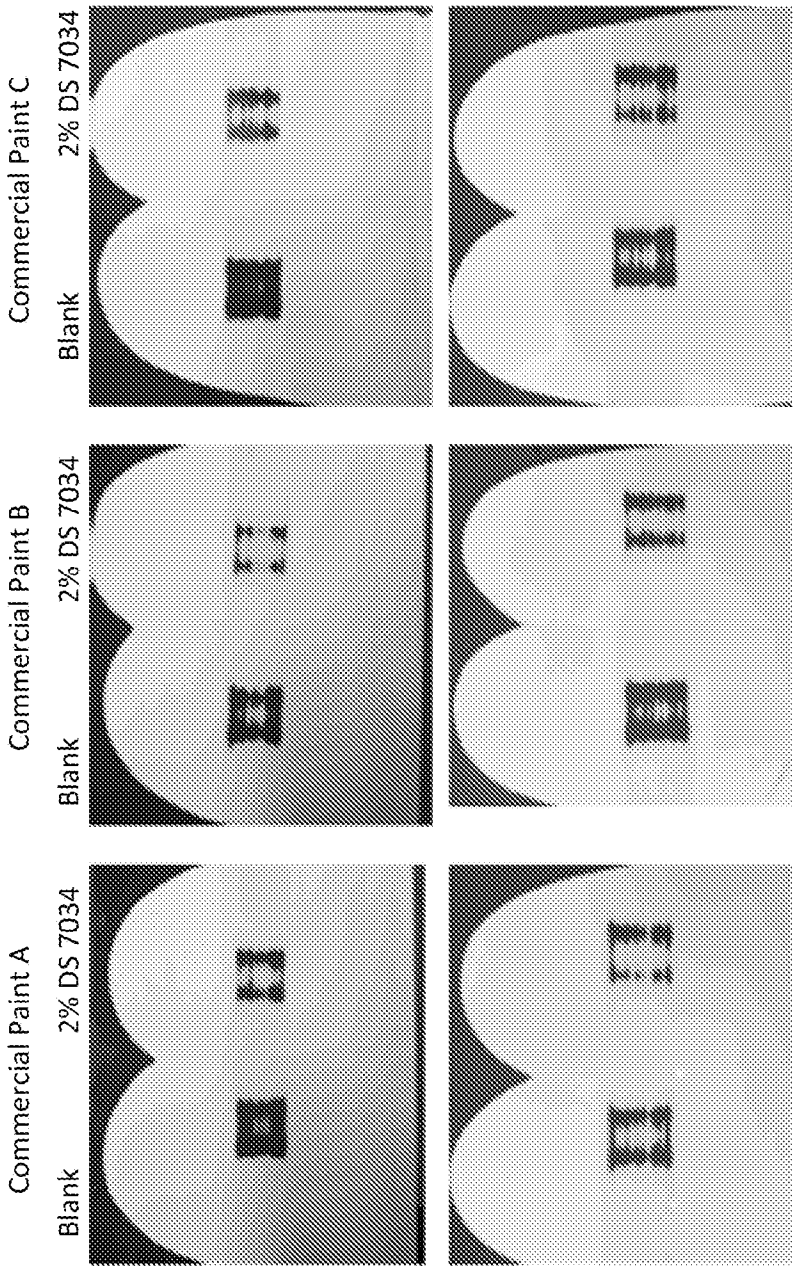

Commercial Paint A
Blank
2% DS 7034
Commercial Paint B
Blank
2% DS 7034
Commercial Paint C
Blank
2% DS 7034
Fresh Paint
Paint Stored at 50 ºC for 8 Days

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 21/50171

A. CLASSIFICATION OF SUBJECT MATTER

IPC - C09D 5/02; C09D 133/06; C08F 8/30; C08K 5/06 (2021.01)

CPC - C09D 5/024; C09D 133/06; C08K 5/0008; C08F 8/30

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)
See Search History document

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 8,304,479 B2 (ZONG et al.) 06 November 2012 (06.11.2012) col 1, ln 24-34; col 2, ln 37-47; col 2, ln 59-67; col 22, ln 25-42; col 24, ln 1-7	1-3, 15-17
A	WO 2019/125455 A1 (HERCULES LLC.) 27 June 2019 (27.06.2019) para [0001], [0005], [0038], [0061], [0067], [0070]	1-3, 15-17
A	US 2018/0094143 A1 (MANKIEWICZ GEBR. & CO. et al.) 05 April 2018 (05.04.2018) para [0012]-[0022], [0047], [0054]	1-3, 15-17
A	US 5,100,907 A (HALL et al.) 31 March 1992 (31.03.1992) col 3, ln 16-24; col 4, ln 31-47; col 5, ln 50-60; col 7, ln 61 to col 8, ln 10; col 20-21, Tables 12, 13, 14, 15	1-3, 15-17
A	US 4,028,378 A (MACFADYEN) 07 June 1977 (07.06.1977) col 1, ln 9-39; col 7, ln 1-5	1-3, 15-17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 November 2021	DEC 20 2021
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Kari Rodriquez Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 21/50171

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-14 and 18-24
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.