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**RELEASE SHEET**

The invention relates to a composite film suitable for use as a release sheet. It more specifically relates to composite films which are suitable for high speed label dispensing machines.

Peelable labels are well known. They are constructed from a release liner upon which there is a release coating, an adhesive and a face stock. The face stock is releasably adhered to the release liner by contact with an adhesive located between the face stock and the release liner.

Typically the release liner is constructed by applying a release coating to one side of a plastic or paper liner sheet. Release coatings are characterized by an ability to adhere strongly to the liner sheet but to adhere weakly to the adhesive which is located between the face stock and the liner.

The peelable label is converted into roll label stock by cutting the composite film with a die which only cuts through the face stock, not through the release liner, to form labels of specified shape. The surrounding face stock, known as the matrix, is stripped away from the release liner, leaving the labels adhered to the release liner which is then formed into a roll. The labels are usually dispensed by bending the roll stock to an angle which causes the label to lift away from the release liner. The label, released from the liner, is then applied to a surface.

In composite films of this type, the release coating is usually made out of an electron beam curable composition which, typically includes a silicone resin having crosslinkable groups, such as acrylic residues. The silicone portion of the composition is the release agent which permits the adhesive to bond lightly to the release liner. The acrylic groups crosslink the release coating composition together and permit the release coating to form a strong bond to the surface of the liner sheet.

There are typically four levels of release force: premium release (10 to 15 g), easy release (20 to 40 g), high release (50 to 100g) and tight release (>100 g). For high speed label dispensing, the release liner should have a high release force.

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If the release force is too low, pre-dispensing occurs in which the labels disengage during die cutting rather than remain on the liner to form the roll stock.

Attempts to increase the release force by the addition of agents designed to strengthen the degree of release of the release coating cause unacceptable zippy noise, or zippiness, during matrix stripping and label dispensing. Zippy noise is an art-recognized term used to describe a jerking noise generated during the high speed matrix stripping process.

This invention seeks to provide a release coating for use in high speed label dispensing machinery which does not cause pre-dispensing problems; for example, an unacceptable degree of zippy noise.

A feature of the invention is a release coating formulation which includes a mixture of (a) a silicone release component, (b) a crosslinking agent and (c) an acrylic ester.

According to one aspect of this invention, there is provided a flexible sheet, suitably but not exclusively for use as a release coated refuse liner, which has one side thereof a crosslinkable release coating comprising a mixture of

(a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and

(c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b).

This invention also provides a crosslinkable release coating composition which comprises :

(a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and

(c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b).

This invention further provides a peelable adhesive film, for example a peelable label, which comprises a flexible sheet according to the invention and a face film stock releasably

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adhered by a tacky adhesive to the cured release coating.

Additionally, the present invention provides the use in a crosslinkable release coating composition which comprises :

(a) a material comprising a silicone moiety and plurality
5 of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising
a plurality of unsaturated carboxylate groups; and

of (c) a monomeric or oligomeric unsaturated carboxylic ester
differing from (a) or (b) to reduce pre-dispensing problems in
10 high speed labelling.

An important feature of the invention is the use of a
monomeric of oligomeric unsaturated carboxylic ester,
preferably an acrylic ester in the release coating formulation.
Suitable such acrylic esters are monomers or oligomers having
15 long chain hydrocarbon groups. The hydrocarbon groups usually
comprise 2 to 24 carbon atoms, specifically from 4 to 12 carbon
atoms. Specific examples of contemplated acrylic esters include
octyl acrylate, isodecyl acrylate, stearyl acrylate and lauryl
acrylate. These materials have viscosity ranges from 2 to 55
20 cP (2 mPas to 55 mPas) at 25°C.

The film form liner is a conventional flexible film
material known in this art. Examples of useful film form liner
materials include paper, oriented polypropylene, polyethylene
terephthalate, polyethylene, polyamides and polystyrene.

25 The release coating is a composition which when applied to
the base liner, has a low surface tack permitting ready release
of other materials such as polymeric films which have been
applied thereto.

The release coating formulation of this invention is,
30 typically, crosslinkable and comprises a mixture of (a) a
silicone release component; (b) a crosslinking agent; and (c)
an acrylic ester.

In general, the (a) silicone release component is a
polydimethyl siloxane silicone polymer which is known to have
35 release characteristics. In general, the silicone polymers are
themselves crosslinkable and have crosslinkable groups.
Crosslinkable silicone polymers of this kind usually have

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appended acrylic residues which are the crosslinkable groups. These crosslinkable silicone release polymers typically contain from 2%, such as 5%, to 30% acrylate, specifically from 10% to about 20% acrylate. An example of a typical release coating is a silicone-acrylate copolymer described in EPA 0281681. An example of a useful silicone-acrylate release polymer is available commercially under the name RC-726 by Goldschmidt Chemical Co.

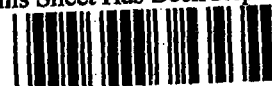
In general the (b) crosslinking agent is present to permit bonding of the (a) silicone release component to the base liner. The crosslinking agent interacts with the acrylate by free radical reactions, typically, induced by high energy radiation, e.g. electron beam or ultra violet light. Conventional crosslinking agents can be employed in the release coating formulation. An example of a contemplated crosslinking agent is a higher acrylate content silicone-acrylate. The high acrylate content silicone-acrylate contemplated as the crosslinking agent is distinguished from the (a) silicone-acrylate by the presence of a higher concentration of the acrylate component. Typically, the (b) silicone-acrylate contains from 5 to 15% more acrylate than the (a) silicone-acrylate. Typically the high acrylate silicone-acrylate contains from 10% to 45%, more specifically from 15% to 30% acrylate based on the entire weight of this crosslinking agent. A high acrylate silicone-acrylate material, which contains about 25 % acrylate is sold commercially under the name RC-705 by Goldschmidt Chemical Co.

Other contemplated (b) crosslinking agents are multi-functionalized, acrylate monomer/oligomer materials. Multi-functionalized acrylates are usually characterized by the presence of 2 or more acrylate groups per molecule. Examples include trimethylolpropane triacrylate (TMPTA) and ethoxylated trimethylolpropane triacrylate (EO-TMPTA). The TMPTA is sold under the name "SR-351" and the EO-TMPTA is sold under the name "SR-454", both sold by Sartomer Chemical Co. of Exton, PA.

The TMPTA and/or EO-TMPTA can be used together with the high acrylate silicone-acrylate crosslinking agent to make-up

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the appropriate amount of crosslinker needed in the release coating. Alternatively, the TMPTA and/or EO-TMPTA or the high acrylate silicone-acrylate can be used alone.

An important feature of this invention is the presence of a (c) acrylic ester in the release coating. The (c) acrylic ester when used with (a) and (b) to form a release coating has been found to produce a high release force release coating material. The (c) acrylic ester permits the above described (a) silicone release component to be used in high speed, high release force label applications. Prior to this invention, easy release force release coatings made from (a) silicone release components were unusable in high release force applications. It is believed that the addition of the (c) acrylic ester modifies the elastic property of the crosslinked silicone release coating.

Contemplated acrylic esters include monomeric and/or oligomeric acrylates. The acrylic esters contemplated are distinguished from the (a) and (b) silicone-acrylates described above by the absence of the silicone component. They are also distinguished from the (b) non-silicone crosslinking agent because they are usually free of more than two acrylate groups. Thus, more specifically, the acrylic ester can be defined as being free of silicone and free of more than 2 acrylate groups per molecule.

Acrylic esters are derivatives of both acrylic acid and methacrylic acid. The contemplated acrylates are specifically long chain alkyl esters containing 2 to 24 carbon atoms, the alkyl groups can be n-alkyl and secondary and branched chain alkyl groups. Typical examples of acrylic esters include octyl acrylate, isodecyl acrylate, stearyl acrylate and lauryl acrylate. Typically the acrylic esters have viscosity ranges from 2 to 55 cP at 25°C (2 mPas to 55 mPas). These acrylic esters are commercially available from several chemical companies, such as Sartomer, UCB Radcure and CPS Chemicals.

The release coating formulation is usually disposed on the base liner in an uncured form and is then cured to fix it in place. One of the techniques used to apply the release coating

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is to coat an uncured composition on a surface of the base liner and then to impinge an electron beam onto this composition for a time and under conditions suitable for converting this coating into a crosslinked film which is adhered to the surface of the base liner. Thus, the crosslinked release coating contains mostly crosslinked silicone acrylate moieties which are bound together and to the surface of the base liner. The coating can also be crosslinked by adding a UV initiator and then exposing the coating to UV light. Typical UV initiators are hydroquinone and hydroquinone derivatives.

The face stock is a conventional film form material. Examples of suitable materials are films of paper, oriented polypropylene, polyethylene terephthalate, polyethylene, polystyrene and metal foils.

The adhesive is any material which will bond weakly to the release liner and strongly to the face stock. Examples of known adhesives include acrylic emulsions, such as those sold commercially under the name XPLA-12, by the Dyna-tech Company, styrene-butadiene rubber emulsions, such as those sold under the name Bond-master 72-9718 by National Starch Company, and hot-melt adhesives, such as those sold under the trade name HL-2021, or HL-2203X by the H.B. Fuller Company.

Included within the scope of this invention is a base liner provided with a skin of a material having tougher physical properties, adjacent to the release coating. This base liner is designed to facilitate label cutting. When the face stock, which is releasably secured to the release coating, is die cut into suitable shapes, the cutting die is prevented from penetrating and cutting through the base liner by the presence of the tougher skin layer.

The proportion of each component described above in the release coating formulation, based on the entire coating formulation, ranges from 15 to 70%, specifically from 20 to 50%, of the (a) silicone release component; from 10% to 50%, specifically from 15% to 30% of the (b) crosslinking agent; and from 10% to 50%, specifically from 20% to 40% of the (c) acrylic ester.

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The following Examples illustrate the invention; parts and percentages are by weight unless expressly stated.

EXAMPLE 1

A release coating was formulated from a curable silicone-
5 acrylate release component (RC-726 manufactured by Goldschmidt
Chemical Co.), various proportions of the crosslinking agents,
ethoxylated trimethylolpropane triacrylate (EO-TMPTA) and high
acrylate silicone acrylate (HASA), and isodecyl acrylate. The
formulated release coating was coated onto a 2.0 mil oriented
10 polypropylene film. After application of the release coating,
the film was radiation cured by exposure to 2.5 Mrad electron
beam radiation on an ESI Electrocurtain CB 150 laboratory EB
unit. The release force of each coated release liner was tested
by a TLMI tester. The TLMI tester is manufactured by TMI Co.,
15 of Amityville, NY. In the test the sandwich laminate is cut
into a 1 inch (25.4 mm) width. The face stock is peeled away
at a 180° angle at a speed of 300 in/minute (1,270 mm/s). The
peel force is reported as the release force. The results are
reported below in Table 1.

20 The release liners were laminated to a high release force
adhesive tape. The peel force at a speed of 3 and 5 meters per
second was measured with IMASS tester. The IMASS tester is
used to measure the release force for high speed operation. The
tester used was model ZPE-1000, manufactured by Instrumentors,
25 Inc., Strongsville OH which can be operated at speeds of 0.5 to
5.0 meters per second. The results are reported in Table 1.

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Table 1

Composition %

Zippy
noise
(IMASS
test)High Speed
Peel Force
(IMASS)Release
Force
(TMI)
24 hr.
(g)isodecyl
acrylateEO-TMPTA³HASA²SA¹

SAMPLE #

3 m/s
(g)5 m/s
(g)

1	50	50	---	---	30	25	13	no
2	30	70	---	---	35	30	20	no
3	50	---	20	30	88	57	38	no
4	67	---	13	20	64	84	58	no
5	33	---	27	40	98	73	62	slight
6	20	48	---	32	157	103	84	slight
7	35	39	---	26	78	104	80	no
8	50	30	---	20	105	159	108	slight
9	50	25	25	---	280	43	34	no
10	50	---	25	25	45	54	48	no
11	50	25	---	25	46	77	68	no
12	50	20	---	30	52	74	70	no
13	40	20	---	40	80	95	87	slight
14	55	15	---	30	55	75	51	no

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- 1 SA = Silicone Acrylate
 2 HASA = High Acrylate Silicone Acrylate
 3 EO-TMPTA = Ethoxylated Trimethylolpropane Triacrylate

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EXAMPLE 2

Samples 1 to 8 were laminated to 60# high gloss paper face stock with a hot melt adhesive on a laboratory Mercer laminator. The laminates were then evaluated for their die cut performance on the Allied Gear Flexmaster1B die cut machine with a 3/4" circular die and the results are reported in Table 2. The percent predispose was determined by counting the number of labels predisposed during matrix stripping at 200 fpm (60.96 m/min) and 500 fpm (152.40 m/min).

10

TABLE 2

Sample # (Table 1)	% Predispose at		Zippiness During Matrix Stripping
	200 fpm	500 fpm	
1	95	100	None
2	98	99	None
3	0	2	Slight
4	2	5	None
5	0	1	Moderate
6	0	1	Slight
7	5	10	None
8	0	3	Slight

The data of Tables 1 and 2 show that release coating formulations made in accordance with this invention increase the release force of a silicone-acrylate release component and reduce the percentage of predisposed labels under high speed applications. The data reported in Table 1 show that silicone acrylate based release coatings formulated with a crosslinking agent, such as high acrylate silicone acrylate and/or ethoxylated trimethylolpropane triacrylate and an acrylate monomer achieve a high release force (>50 g) with only slight or no zippy noise. Varying the proportion of each component can optimize release coating performance. Additionally, as shown in Table 2, the amount of predisposed labels at high speeds is minimized by the use of the coating formulation of this invention.

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CLAIMS

1. A flexible sheet which has on one side thereof a crosslinkable release coating comprising a mixture of :
 - (a) a material comprising a silicone moiety and plurality
5 of unsaturated carboxylate groups;
 - (b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and
 - (c) a monomeric or oligomeric unsaturated carboxylic ester
10 differing from (a) or (b).
2. A flexible sheet according to claim 1 wherein, in (a), the unsaturated carboxylate groups comprise from 2 to 30 wt.% of (a) of acrylate groups.
- 15 3. A flexible sheet according to claim 1 or 2 wherein (b) comprises (i) a silicone-acrylate material of higher acrylate content than (a) or (ii) a monomeric or oligomeric multi-functional acrylate.
- 20 4. A flexible sheet according to any preceding claim wherein (c) comprises a C_2 to C_{24} alkyl acrylate monomer or oligomer.
5. A flexible sheet according to any preceding claim wherein (a) comprises from 15 to 70 wt.%; (b) comprises from 10 to 50
25 wt.%; and (c) comprises from 10 to 50 wt.% of the weight of the mixture.
6. A flexible sheet according to any preceding claim wherein the sheet comprises paper, polypropylene, polyethylene,
30 polyethylene terephthalate, polyamide or polystyrene.
7. A flexible sheet according to any preceding claim for use as a release coated release liner.
- 35 8. A peelable adhesive film which comprises a flexible sheet according to any of claims 1 to 7 and a face film stock releasably adhered by a tacky adhesive to the cured release

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coating.

9. A crosslinkable release coating composition which comprises:

- 5 (a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;
- (b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and
- 10 (c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b).

10. Use in a crosslinkable release coating composition which comprises :

- 15 (a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;
- (b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and
- of (c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b) to reduce pre-dispensing problems in
- 20 high speed labelling.

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ABSTRACT

A composite sheet of a flexible release liner, which is useful in high speed operations, the release liner is coated on one side with a crosslinkable high release coating formulation comprising (a) a silicone-acrylate release component; (b) an acrylate-containing crosslinking agent, such as a silicon-acrylate crosslinking agent having a higher acrylate content than the (a) silicone-acrylate, trimethylolpropane triacrylate or epoxylated trimethylolpropane triacrylate; and (c) an acrylic ester monomer or oligomer selected from the group consisting of octyl acrylate, isodecyl acrylate, stearyl acrylate and lauryl acrylate, specifically the (c) acrylate is free of silicone and more than two acrylate groups per molecule.

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RELEASE SHEET	

The invention relates to a composite film suitable for use as a release sheet. It more specifically relates to composite films which are suitable for high speed label dispensing machines.

Peelable labels are well known. They are constructed from a release liner upon which there is a release coating, an adhesive and a face stock. The face stock is releasably adhered to the release liner by contact with an adhesive located between the face stock and the release liner.

Typically the release liner is constructed by applying a release coating to one side of a plastic or paper liner sheet. Release coatings are characterized by an ability to adhere strongly to the liner sheet but to adhere weakly to the adhesive which is located between the face stock and the liner.

The peelable label is converted into roll label stock by cutting the composite film with a die which only cuts through the face stock, not through the release liner, to form labels of specified shape. The surrounding face stock, known as the matrix, is stripped away from the release liner, leaving the labels adhered to the release liner which is then formed into a roll. The labels are usually dispensed by bending the roll stock to an angle which causes the label to lift away from the release liner. The label, released from the liner, is then applied to a surface.

In composite films of this type, the release coating is usually made out of an electron beam curable composition which, typically includes a silicone resin having crosslinkable groups, such as acrylic residues. The silicone portion of the composition is the release agent which permits the adhesive to bond lightly to the release liner. The acrylic groups crosslink the release coating composition together and permit the release coating to form a strong bond to the surface of the liner sheet.

There are typically four levels of release force: premium release (10 to 15 g), easy release (20 to 40 g), high release (50 to 100g) and tight release (>100 g). For high speed label dispensing, the release liner should have a high release force.

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If the release force is too low, pre-dispensing occurs in which the labels disengage during die cutting rather than remain on the liner to form the roll stock.

Attempts to increase the release force by the addition of agents designed to strengthen the degree of release of the release coating cause unacceptable zippy noise, or zippiness, during matrix stripping and label dispensing. Zippy noise is an art-recognized term used to describe a jerking noise generated during the high speed matrix stripping process.

This invention seeks to provide a release coating for use in high speed label dispensing machinery which does not cause pre-dispensing problems; for example, an unacceptable degree of zippy noise.

A feature of the invention is a release coating formulation which includes a mixture of (a) a silicone release component, (b) a crosslinking agent and (c) an acrylic ester.

According to one aspect of this invention, there is provided a flexible sheet, suitably but not exclusively for use as a release coated refuse liner, which has one side thereof a crosslinkable release coating comprising a mixture of

(a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and

(c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b).

This invention also provides a crosslinkable release coating composition which comprises :

(a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and

(c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b).

This invention further provides a peelable adhesive film, for example a peelable label, which comprises a flexible sheet according to the invention and a face film stock releasably

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adhered by a tacky adhesive to the cured release coating.

Additionally, the present invention provides the use in a crosslinkable release coating composition which comprises :

(a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and

of (c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b) to reduce pre-dispensing problems in high speed labelling.

An important feature of the invention is the use of a monomeric or oligomeric unsaturated carboxylic ester, preferably an acrylic ester in the release coating formulation. Suitable such acrylic esters are monomers or oligomers having long chain hydrocarbon groups. The hydrocarbon groups usually comprise 2 to 24 carbon atoms, specifically from 4 to 12 carbon atoms. Specific examples of contemplated acrylic esters include octyl acrylate, isodecyl acrylate, stearyl acrylate and lauryl acrylate. These materials have viscosity ranges from 2 to 55 cP (2 mPas to 55 mPas) at 25°C.

The film form liner is a conventional flexible film material known in this art. Examples of useful film form liner materials include paper, oriented polypropylene, polyethylene terephthalate, polyethylene, polyamides and polystyrene.

The release coating is a composition which when applied to the base liner, has a low surface tack permitting ready release of other materials such as polymeric films which have been applied thereto.

The release coating formulation of this invention is, typically, crosslinkable and comprises a mixture of (a) a silicone release component; (b) a crosslinking agent; and (c) an acrylic ester.

In general, the (a) silicone release component is a polydimethyl siloxane silicone polymer which is known to have release characteristics. In general, the silicone polymers are themselves crosslinkable and have crosslinkable groups. Crosslinkable silicone polymers of this kind usually have

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appended acrylic residues which are the crosslinkable groups. These crosslinkable silicone release polymers typically contain from 2%, such as 5%, to 30% acrylate, specifically from 10% to about 20% acrylate. An example of a typical release coating is a silicone-acrylate copolymer described in EPA 0281681. An example of a useful silicone-acrylate release polymer is available commercially under the name RC-726 by Goldschmidt Chemical Co.

In general the (b) crosslinking agent is present to permit bonding of the (a) silicone release component to the base liner. The crosslinking agent interacts with the acrylate by free radical reactions, typically, induced by high energy radiation, e.g. electron beam or ultra violet light. Conventional crosslinking agents can be employed in the release coating formulation. An example of a contemplated crosslinking agent is a higher acrylate content silicone-acrylate. The high acrylate content silicone-acrylate contemplated as the crosslinking agent is distinguished from the (a) silicone-acrylate by the presence of a higher concentration of the acrylate component. Typically, the (b) silicone-acrylate contains from 5 to 15% more acrylate than the (a) silicone-acrylate. Typically the high acrylate silicone-acrylate contains from 10% to 45%, more specifically from 15% to 30% acrylate based on the entire weight of this crosslinking agent. A high acrylate silicone-acrylate material, which contains about 25 % acrylate is sold commercially under the name RC-705 by Goldschmidt Chemical Co.

Other contemplated (b) crosslinking agents are multifunctionalized, acrylate monomer/oligomer materials. Multifunctionalized acrylates are usually characterized by the presence of 2 or more acrylate groups per molecule. Examples include trimethylolpropane triacrylate (TMPTA) and ethoxylated trimethylolpropane triacrylate (EO-TMPTA). The TMPTA is sold under the name "SR-351" and the EO-TMPTA is sold under the name "SR-454", both sold by Sartomer Chemical Co. of Exton, PA.

The TMPTA and/or EO-TMPTA can be used together with the high acrylate silicone-acrylate crosslinking agent to make-up

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the appropriate amount of crosslinker needed in the release coating. Alternatively, the TMPTA and/or EO-TMPTA or the high acrylate silicone-acrylate can be used alone.

An important feature of this invention is the presence of a (c) acrylic ester in the release coating. The (c) acrylic ester when used with (a) and (b) to form a release coating has been found to produce a high release force release coating material. The (c) acrylic ester permits the above described (a) silicone release component to be used in high speed, high release force label applications. Prior to this invention, easy release force release coatings made from (a) silicone release components were unusable in high release force applications. It is believed that the addition of the (c) acrylic ester modifies the elastic property of the crosslinked silicone release coating.

Contemplated acrylic esters include monomeric and/or oligomeric acrylates. The acrylic esters contemplated are distinguished from the (a) and (b) silicone-acrylates described above by the absence of the silicone component. They are also distinguished from the (b) non-silicone crosslinking agent because they are usually free of more than two acrylate groups. Thus, more specifically, the acrylic ester can be defined as being free of silicone and free of more than 2 acrylate groups per molecule.

Acrylic esters are derivatives of both acrylic acid and methacrylic acid. The contemplated acrylates are specifically long chain alkyl esters containing 2 to 24 carbon atoms, the alkyl groups can be n-alkyl and secondary and branched chain alkyl groups. Typical examples of acrylic esters include octyl acrylate, isodecyl acrylate, stearyl acrylate and lauryl acrylate. Typically the acrylic esters have viscosity ranges from 2 to 55 cP at 25°C (2 mPas to 55 mPas). These acrylic esters are commercially available from several chemical companies, such as Sartomer, UCB Radcure and CPS Chemicals.

The release coating formulation is usually disposed on the base liner in an uncured form and is then cured to fix it in place. One of the techniques used to apply the release coating

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is to coat an uncured composition on a surface of the base liner and then to impinge an electron beam onto this composition for a time and under conditions suitable for converting this coating into a crosslinked film which is adhered to the surface of the base liner. Thus, the crosslinked release coating contains mostly crosslinked silicone acrylate moieties which are bound together and to the surface of the base liner. The coating can also be crosslinked by adding a UV initiator and then exposing the coating to UV light. Typical UV initiators are hydroquinone and hydroquinone derivatives.

The face stock is a conventional film form material. Examples of suitable materials are films of paper, oriented polypropylene, polyethylene terephthalate, polyethylene, polystyrene and metal foils.

The adhesive is any material which will bond weakly to the release liner and strongly to the face stock. Examples of known adhesives include acrylic emulsions, such as those sold commercially under the name XPLA-12, by the Dyna-tech Company, styrene-butadiene rubber emulsions, such as those sold under the name Bond-master 72-9718 by National Starch Company, and hot-melt adhesives, such as those sold under the trade name HL-2021, or HL-2203X by the H.B. Fuller Company.

Included within the scope of this invention is a base liner provided with a skin of a material having tougher physical properties, adjacent to the release coating. This base liner is designed to facilitate label cutting. When the face stock, which is releasably secured to the release coating, is die cut into suitable shapes, the cutting die is prevented from penetrating and cutting through the base liner by the presence of the tougher skin layer.

The proportion of each component described above in the release coating formulation, based on the entire coating formulation, ranges from 15 to 70%, specifically from 20 to 50%, of the (a) silicone release component; from 10% to 50%, specifically from 15% to 30% of the (b) crosslinking agent; and from 10% to 50%, specifically from 20% to 40% of the (c) acrylic ester.

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The following Examples illustrate the invention; parts and percentages are by weight unless expressly stated.

EXAMPLE 1

A release coating was formulated from a curable silicone-acrylate release component (RC-726 manufactured by Goldschmidt Chemical Co.), various proportions of the crosslinking agents, ethoxylated trimethylolpropane triacrylate (EO-TMPTA) and high acrylate silicone acrylate (HASA), and isodecyl acrylate. The formulated release coating was coated onto a 2.0 mil oriented polypropylene film. After application of the release coating, the film was radiation cured by exposure to 2.5 Mrad electron beam radiation on an ESI Electrocurtain CB 150 laboratory EB unit. The release force of each coated release liner was tested by a TLMI tester. The TLMI tester is manufactured by TMI Co., of Amityville, NY. In the test the sandwich laminate is cut into a 1 inch (25.4 mm) width. The face stock is peeled away at a 180° angle at a speed of 300 in/minute (1,270 mm/s). The peel force is reported as the release force. The results are reported below in Table 1.

The release liners were laminated to a high release force adhesive tape. The peel force at a speed of 3 and 5 meters per second was measured with IMASS tester. The IMASS tester is used to measure the release force for high speed operation. The tester used was model ZPE-1000, manufactured by Instrumentors, Inc., Strongsville OH which can be operated at speeds of 0.5 to 5.0 meters per second. The results are reported in Table 1.

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Table 1

Composition &

SAMPLE #	SA ¹	HASA ²	EO-TMPTA ³	isodecyl acrylate	Release Force (TMI) 24 hr. (g)	3 m/s (g)	5 m/s (g)	High Speed Peel Force (IMASS)	Zippy noise (IMASS test)
1	50	50	---	---	30	25	13		no
2	30	70	---	---	35	30	20		no
3	50	---	20	30	88	57	38		no
4	67	---	13	20	64	84	58		no
5	33	---	27	40	98	73	62		slight
6	20	48	---	32	157	103	84		slight
7	35	39	---	26	78	104	80		no
8	50	30	---	20	105	159	108		slight
9	50	25	25	---	280	43	34		no
10	50	---	25	25	45	54	48		no
11	50	25	---	25	46	77	68		no
12	50	20	---	30	52	74	70		no
13	40	20	---	40	80	95	87		slight
14	55	15	---	30	55	75	51		no

¹ SA = Silicone Acrylate² HASA = High Acrylate Silicone Acrylate³ EO-TMPTA = Ethoxylated Trimethylolpropane Triacrylate

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EXAMPLE 2

Samples 1 to 8 were laminated to 60# high gloss paper face stock with a hot melt adhesive on a laboratory Mercer laminator. The laminates were then evaluated for their die cut performance on the Allied Gear Flexmaster18 die cut machine with a 3/4" circular die and the results are reported in Table 2. The percent predispose was determined by counting the number of labels predisposed during matrix stripping at 200 fpm (60.96 m/min) and 500 fpm (152.40 m/min).

TABLE 2

Sample # (Table 1)	% Predispose at		Zippiness During Matrix Stripping
	200 fpm	500 fpm	
1	95	100	None
2	98	99	None
3	0	2	Slight
4	2	5	None
5	0	1	Moderate
6	0	1	Slight
7	5	10	None
8	0	3	Slight

The data of Tables 1 and 2 show that release coating formulations made in accordance with this invention increase the release force of a silicone-acrylate release component and reduce the percentage of predisposed labels under high speed applications. The data reported in Table 1 show that silicone acrylate based release coatings formulated with a crosslinking agent, such as high acrylate silicone acrylate and/or ethoxylated trimethylolpropane triacrylate and an acrylate monomer achieve a high release force (>50 g) with only slight or no zippy noise. Varying the proportion of each component can optimize release coating performance. Additionally, as shown in Table 2, the amount of predisposed labels at high speeds is minimized by the use of the coating formulation of this invention.

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CLAIMS

1. A flexible sheet which has on one side thereof a crosslinkable release coating comprising a mixture of :

(a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and

(c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b).

2. A flexible sheet according to claim 1 wherein, in (a), the unsaturated carboxylate groups comprise from 2 to 30 wt.% of (a) of acrylate groups.

3. A flexible sheet according to claim 1 or 2 wherein (b) comprises (i) a silicone-acrylate material of higher acrylate content than (a) or (ii) a monomeric or oligomeric multi-functional acrylate.

4. A flexible sheet according to any preceding claim wherein (c) comprises a C_2 to C_{24} alkyl acrylate monomer or oligomer.

5. A flexible sheet according to any preceding claim wherein (a) comprises from 15 to 70 wt.%; (b) comprises from 10 to 50 wt.%; and (c) comprises from 10 to 50 wt.% of the weight of the mixture.

6. A flexible sheet according to any preceding claim wherein the sheet comprises paper, polypropylene, polyethylene, polyethylene terephthalate, polyamide or polystyrene.

7. A flexible sheet according to any preceding claim for use as a release coated release liner.

8. A peelable adhesive film which comprises a flexible sheet according to any of claims 1 to 7 and a face film stock releasably adhered by a tacky adhesive to the cured release

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coating.

9. A crosslinkable release coating composition which comprises:

(a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and

(c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b).

10. Use in a crosslinkable release coating composition which comprises :

(a) a material comprising a silicone moiety and plurality of unsaturated carboxylate groups;

(b) a crosslinking agent, differing from (a), comprising a plurality of unsaturated carboxylate groups; and

of (c) a monomeric or oligomeric unsaturated carboxylic ester differing from (a) or (b) to reduce pre-dispensing problems in high speed labelling.

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ABSTRACT

RELEASE SHEET

A composite sheet of a flexible release liner, which is useful in high speed operations, the release liner is coated on one side with a crosslinkable high release coating formulation comprising (a) a silicone-acrylate release component; (b) an acrylate-containing crosslinking agent, such as a silicon-acrylate crosslinking agent having a higher acrylate content than the (a) silicone-acrylate, trimethylolpropane triacrylate or epoxylated trimethylolpropane triacrylate; and (c) an acrylic ester monomer or oligomer selected from the group consisting of octyl acrylate, isodecyl acrylate, stearyl acrylate and lauryl acrylate, specifically the (c) acrylate is free of silicone and more than two acrylate groups per molecule.

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