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(54) Title: HOTMELT PRESSURE SENSITIVE ADHESIVE FOR CLEAR ON CLEAR LABELS

(57) Abstract: A hotmelt pressure sensitive adhesive comprising a low diblock grade SIS as base polymer, low viscosity and molecular weight hydrogenated cycloaliphatic hydrocarbon resin as tackifier, high viscosity and molecular weight paraffin oil with high molecular weight as plasticizer, and polyethylene wax. The adhesive can achieve performance characteristics that include clear on clear labeling for beverage bottles, transparency, water-whitening resistance, repositionability within the first 4 to 8 hours after label application, low swelling for film facestock, low viscosity for processibility of compounding and coating, low odor, and light color.

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HOTMELT PRESSURE SENSITIVE ADHESIVE FOR CLEAR ON CLEAR LABELS

FIELD OF THE INVENTION

[0001] The present invention relates generally to compositions for pressure sensitive adhesives and, in particular, to improved adhesives that provide higher quality labels while maintaining good processability in methods that include compounding and coating the improved adhesive.

BACKGROUND OF THE INVENTION

[0002] Adhesive labels and tapes are well known. In a typical label construction, one or more layers of adhesive are coated on or otherwise applied to a release liner, and then laminated to a facestock, such as paper, polymeric film, or other ink-receptive, flexible material. In a typical tape construction, a polymeric film or woven paper is coated with an adhesive on one surface, which is then wound up upon itself. The adhesives used in both tapes and labels include rubber-based and acrylic-based pressure-sensitive adhesives (PSAs). PSAs can be applied to a release liner or facestock from an organic solvent, from an aqueous dispersion, or as a hotmelt.

[0003] Hotmelt PSAs (HMPSAs) can provide a convenient and economical way to label articles of commerce such as glass, metal, and plastic containers for consumer and industrial products. HMPSAs are easy to handle in their solid form, they quickly form adhesive bonds without any supplementary processing, and they generally have a long shelf life. Also, HMPSAs are often environmentally friendly and cost effective since they do not comprise solvents.

[0004] An example of an HMPSA can found in US Patent No. 5,942,569, which describes a polymeric composition in pellet form comprising a tacky hot melt composition, comprising a) from about 5% by weight to about 90% by weight of a thermoplastic polymer, b) from about 0% by weight to about 65% by weight of a tackifying resin, c) from about 0% to about 50% by weight of a plasticizer, d) up to about 2% by weight of an antioxidant, and a pelletizing aid, wherein the tacky hot melt composition has some minimum amount of tackifier or plasticizer and is a pressure sensitive adhesive having a storage modulus, G' , at about 25 °C, of less than about 5×10^6 dynes/cm², and each pellet has a substantially tack-free surface. The discloses further includes a polymeric composition in pellet form suitable for molding articles. The composition

comprises a tacky hot melt composition comprising at least one high molecular weight triblock copolymer of the general configuration A-B-A and a plasticizer and a pelletizing aid. The pelletizing aid substantially surrounds the tacky composition such that the molded articles are substantially free from surface tack. A method of forming the pellets is also disclosed.

[0005] The HMPSA of US Patent No. 7,595,365 discloses the use of a polyalphaolefin oil or combinations of polyalphaolefin oils to modify the softening point characteristics of a tackifier. The disclosure further includes compositions containing a tackifier and polyalphaolefin oil.

[0006] US Patent No. 8,076,422 discloses a hot-melt adhesive for resealable packaging, containing 30 to 90 weight% of at least one copolymer based on ethylene and/or propylene together with C₄ to C₁₂ alpha olefins, which is obtainable by metallocene-catalyzed polymerization, with a melt index of 5 to 100 g/10 min (DIN ISO 1133). The adhesive further includes 5 to 50 weight% of tackifier resins with a softening point of 80 to 140 °C, 0 to 15 weight% of waxes with a melting point of 120 to 170 °C, and 0.1 to 20 weight% of additives and auxiliaries. The adhesive has a viscosity of 25,000 mPas to 250,000 mPas, measured at a temperature of 170 to 190 °C.

[0007] Further HMPSA compositions are also provided by US Patent No. 9,242,437; U.S. Patent Application Publication Nos. US 2005/0013996, US 2006/0251890, US 2010/0193127, and US 2016/0272856; and International Patent Application Publication Nos. WO 2002/074837 and WO 2006/107763.

[0008] Even in view of these references, the need exists for high performance HMPSAs that provide improvements in performance characteristics, e.g., water whitening resistance, repositionability, and/or optical clarity.

SUMMARY OF THE INVENTION

[0009] In one embodiment, the invention is to a hotmelt pressure sensitive adhesive. The adhesive comprises a base polymer, wherein the base polymer comprises a styrene-isoprene copolymer. Preferable the base polymer has a diblock grade of less than 30 weight%. The adhesive further comprises a tackifier, wherein the tackifier comprises a hydrogenated cycloaliphatic hydrocarbon resin. Preferably, the tackifier has a weight average molecular weight within the range from 300 to 800. The adhesive further comprises a plasticizer, wherein the plasticizer comprises a paraffin oil having a kinematic viscosity at 40 °C within the range from

400 to 1000 mm²/second. Preferably, the plasticizer has a number average molecular weight within the range from 400 to 1000, and a kinematic viscosity at 40 °C within the range from 400 to 700 mm²/second. The adhesive can further comprise a polyethylene wax. Preferably, the polyethylene wax has a dynamic viscosity at 140 °C within the range from 150 to 500 centipoise, and a pour point of greater than 100 °C.

[0010] In another embodiment the invention relates to a label. The label comprises a layer of facestock for receiving printed indicia. The label further comprises a layer of hotmelt pressure sensitive adhesive in accordance with an embodiment.

[0011] In another embodiment, the invention is to a labeled container. The labeled container comprises a container defining an outer surface. The labeled container further comprises a label in accordance with an embodiment, adhered to the outer face of the container.

[0012] In another embodiment, the invention is to a method of applying a label to a container. The method comprises providing a container defining an outer surface. The method further comprises providing a label in accordance with an embodiment. The method further comprises adhering the label to the outer surface of the container, thereby applying the label to the container.

BRIEF DESCRIPTION OF DRAWINGS

[0013] The invention is described in detail below with reference to the appended drawings, wherein like numerals designate similar parts.

[0014] FIG. 1 is a schematic illustration of a labeled container such as a bottle in accordance with one embodiment of the present invention.

[0015] FIG. 2 is a schematic illustration of a cross-sectional view of a label having a layer of facestock, a layer of hotmelt pressure sensitive adhesive, and a liner, in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] The present invention generally relates to hotmelt pressure sensitive adhesives (HMPSAs) that, when employed in label applications, provide advantageous combinations of performance characteristics, while maintaining good processability. For example, it is beneficial for adhesives that are exposed to wet or humid environments to have a high level of water

whitening resistance. Such wet conditions are common for adhesive labels that are applied to glass or plastic bottles used to contain beverages, personal care products, or other items. It can also be useful for a label to be removable and/or repositionable, without leaving significant adhesive residue on the bottle or other container from which the label is removed. This characteristic can be particularly important for containers that are to be reused or recycled. Additionally, adhesives that are optically clear or transparent can allow an attached label to be viewed through a similarly clear or transparent container, such as a glass bottle, to which the label is adhered. The ability of an adhesive to be easily processed can also be a preferred characteristic, allowing the adhesive to better form coating layers of high quality on labels or other items.

[0017] It is difficult, however, for an HMPSA to demonstrate all of the above characteristics simultaneously. One reason for this is that a component that improves one characteristic often has a detrimental effect on another characteristic. For example, the desired traits of low water whitening and repositionability can be associated with the use of adhesive components that have high molecular weights and high viscosities. However, the desired traits of ease of compounding and high quality of coating are often negatively affected by the use of adhesive components that have high molecular weights and high viscosities.

[0018] The inventors have now discovered that particular combinations of components, optionally utilized in specific amounts, surprisingly provide for high performance HMPSAs that demonstrate highly desirable combinations of performance characteristics, e.g., water whitening resistance, repositionability, and/or optical clarity. Beneficially, these HMPSAs also show improvements in processability during adhesive and label manufacture and application, and good adhesive and label quality in a finished end user product.

[0019] In particular, it has been found that an HMPSA composition comprising a plasticizer comprising a paraffin oil; and a tackifier comprising a hydrogenated cycloaliphatic hydrocarbon resin; each optionally having a molecular weight and viscosity within specific ranges, surprisingly provides for an HMPSA having the aforementioned combinations of performance characteristics. For example, the adhesive can be used to produce a label that has good transparency, repositionability, and resistance to whitening, oil migration, swelling, or wrinkling, while still being easy to use in standard compounding and coating applications.

[0020] Without being bound by a particular theory, it is believed that the paraffin oil has good compatibility with the SIS block copolymer that is the base of the HMPSA because both the paraffin oil and the SIS block copolymer have linear molecular structures. The internal interactions of these components of the adhesive layer can act to, for example, limit oil migration and control the swelling and wrinkling of an adhered polymer-structured filmic facestock. Additionally, the low molecular weight of the hydrogenated cycloaliphatic hydrocarbon resin relative to that of linear aliphatic hydrocarbon resins can allow the hydrogenated cycloaliphatic resin to increase the processability of the HMPSA without negatively affecting its softening point. Because the HMPSA composition as a whole has a bulk hydrophobicity, water whitening of the adhesive is also minimized.

[0021] In one embodiment, the HMPSA includes a base polymer, a tackifier, and a plasticizer. In some embodiments, the HMPSA also includes a polyethylene wax. In some embodiments, the base polymer comprises a styrene-isoprene-styrene (SIS) copolymer, the tackifier comprises a hydrogenated cycloaliphatic hydrocarbon resin, and the plasticizer comprises a paraffin oil. In preferred embodiments, the plasticizer has a kinematic viscosity at 40 °C within the range from 400 to 1000 mm²/second.

[0022] The base polymer of the HMPSA includes an SIS block copolymer, where "S" denotes a polymerized segment or "block" of styrene monomers, and "I" denotes a polymerized segment or "block" of isoprene monomers. SIS block copolymers can be a pure triblock copolymer containing no SI diblock, or can contain a certain percentage of SI diblock. It has been found that higher diblock content may be associated with an increase in tack of the SIS block copolymer, and a lower diblock content may be associated with an increase in elasticity of the copolymer. The diblock content of the HMPSA base polymer can be within the range from 0 to 50 weight%, e.g., from 0 to 30 weight%, from 5 to 35 weight%, from 10 to 40 weight%, from 15 to 45 weight%, or from 20 to 50 weight%. In terms of upper limits, the diblock content can be less than 50 weight %, e.g., less than 45 weight%, less than 40 weight%, less than 35 weight%, less than 30 weight%, less than 25 weight%, less than 20 weight%, less than 15 weight%, less than 10 weight%, or less than 5 weight%. In terms of lower limits, the diblock content can be at least 5 weight%, at least 10 weight%, at least 15 weight%, at least 20 weight%, at least 25 weight%, at least 30 weight%, at least 35 weight%, at least 40 weight%, or at least 45 weight%. In some embodiments, the base polymer has a diblock grade of less than 30 weight%.

[0023] The styrene content of the SIS block copolymer can also impact the performance characteristics of the base polymer. It has been found that a particular styrene content, along with a particular diblock content, can give a base polymer the desired properties of a high melt flow index (greater than 20 g per 10 minutes at 190 °C) and a low viscosity. Together these properties make the polymer more suitable for compounding and coating processes. The styrene content of the base polymer can be within the range from 0 to 50 weight%, e.g., from 0 to 30 weight%, from 5 to 35 weight%, from 10 to 40 weight%, from 15 to 45 weight%, or from 20 to 50 weight%. In terms of upper limits, the styrene content can be less than 50 weight %, e.g., less than 45 weight%, less than 40 weight%, less than 35 weight%, less than 30 weight%, less than 25 weight%, less than 20 weight%, less than 15 weight%, less than 10 weight%, or less than 5 weight%. In terms of lower limits, the styrene content can be at least 5 weight%, at least 10 weight%, at least 15 weight%, at least 20 weight%, at least 25 weight%, at least 30 weight%, at least 35 weight%, at least 40 weight%, or at least 45 weight%. In some embodiments, the base polymer has a styrene content of less than 25 weight%.

[0024] The amount of the SIS block copolymer within the HMPSA composition can be within the range from 15 to 65 weight%, e.g., from 15 to 45, from 20 to 50, from 25 to 55, from 30 to 60, or from 35 to 65 weight%. The amount of the SIS block copolymer within the HMPSA composition can be within the range from 30 to 50 weight%, e.g., from 30 to 42, from 32 to 44, from 34 to 46, from 36 to 48, or from 38 to 50 weight%. In terms of upper limits, the amount of the SIS block copolymer within the HMPSA composition can be less than 70, less than 65, less than 60, less than 55, less than 50, less than 45, or less than 40 weight%. In terms of lower limits, the amount of the SIS block copolymer within the HMPSA composition can be at least 10, at least 15, at least 20, at least 25, at least 30, at least 35, or at least 40 weight%.

[0025] Suitable commercially available linear SIS block copolymers include, for example, SIS 1220, available from Shandong Jusage Technology Company, Ltd. (Shandong, China); Quintac 3433 and Quintac 3421, available from Nippon Zeon Company, Ltd. (Louisville, Ky.); Vector DPX 559, Vector 4111 and Vector 4113, available from Dexco, a partnership of Exxon Chemical Co. (Houston, Tex.) and Dow Chemical Co. (Midland Mich.); and KRATON™ rubbers, such as Kraton 604x, Kraton D-1117, Kraton D-1107 and Kraton D-1113, available from Shell Chemical Co. (Houston, Tex.).

[0026] In one embodiment, the plasticizer, e.g., the paraffin oil plasticizer, is a high molecular weight paraffin oil. The use of this high molecular weight plasticizer has been found to provide many advantages to the adhesive not observed with conventional HMPSA compositions. For example, the resultant adhesive has an improved ability to be repositioned after first applied to a substrate. More specifically, in some embodiments a label using the adhesive can be removed, e.g., substantially completely removed from and reapplied to the substrate, e.g., a polyethylene phthalate (PET) or glass bottle, within the first 12 hours (e.g., within the first 11 hours, 10 hours, 9 hours, 8 hours, 7 hours, 6 hours, 5 hours, or 4 hours) after initial application at a temperature above 5 °C. FIG. 1 illustrates an example of such a labeled bottle 100, with a label 101 applied to an outer surface 102 of the bottle 100. Because of the particular HMPSA composition, such a label can also be removed cleanly, with substantially complete removal of the adhesive from the outer surface of a glass or PET container, after longer periods of time. The term "substantially complete removal" is used herein to refer to removal with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% of the adhesive being retained with the label and not with the outer surface of the container to which the label is adhered.

[0027] Another advantage of the high molecular weight paraffin oil is that the adhesive can be used to create labels with greater structural integrity. For example, labels that include the HMPSA can exhibit reduced wrinkling and swelling. Reduced swelling can indicate a change in size of less than 5%, less than 4%, less than 3%, less than 2%, or less than 1% over a predetermined measurement period. The swelling and wrinkling measurement period can be greater than 3 days, greater than 4 days, greater than 5 days, greater than 6 days, greater than 7 days, greater than 8 days, greater than 9 days, or greater than 10 days. The reduced swelling and wrinkling can be observed during storage at a temperature greater than 45 °C, greater than 50 °C, greater than 55 °C, greater than 60 °C, greater than 65 °C, or greater than 70 °C. The reduced swelling and wrinkling can be observed during storage at a relative humidity greater than 80%, greater than 82%, greater than 84%, greater than 86%, greater than 88%, or greater than 90%. In some embodiments, the label that includes the HMPSA has either no change in size, or changes in each dimension (e.g., machine direction and cross direction) that are less than 2%, upon storage at 85% relative humidity for either 4 days at greater than 65 °C, or 7 days at greater than 50 °C.

[0028] Also, these paraffin oils have surprisingly been found to enhance the stability of labels, with lower migration of oils within and among the layers of a label, and less leakage of adhesion beyond the original footprint of the adhered label. These improvements not only increase the effectiveness of the label in adhering to items and anchoring and retaining printed indices, but also increase the visual presentation of the label from the perspective of an end user. As labels are often used to present important information, or to increase the visibility or appeal of consumer products, these improvements can enhance the value of the labels significantly.

[0029] The amount of the paraffin oil plasticizer within the HMPSA composition can be within the range from 5 to 35 weight%, e.g., from 5 to 23, from 8 to 26, from 11 to 29, from 14 to 32, or from 17 to 35 weight%. The amount of the paraffin oil plasticizer within the HMPSA composition can be within the range from 14 to 26 weight%, e.g., from 14 to 21.2, from 15.2 to 22.4, from 16.4 to 23.6, from 17.6 to 24.8, or from 18.8 to 26 weight%. In terms of upper limits, the amount of the paraffin oil plasticizer within the HMPSA composition can be less than 38, less than 35, less than 32, less than 29, less than 26, less than 23, or less than 20 weight%. In terms of lower limits, the amount of the paraffin oil plasticizer within the HMPSA composition can be at least 2, at least 5, at least 8, at least 11, at least 14, at least 17, or at least 20 weight%.

[0030] The paraffin oil plasticizer can have a number average molecular weight that ranges from 400 to 1000, e.g., from 400 to 700, from 500 to 800, from 600 to 900, from 700 to 1000, from 400 to 500, from 500 to 600, from 600 to 700, from 700 to 800, from 800 to 900, or from 900 to 1000. In terms of upper limits, the plasticizer can have a number average molecular weight that is less than 1000, e.g., less than 900, less than 800, less 700, less than 600, or less than 500. In terms of lower limits, the plasticizer can have a number average molecular weight that is at least 400, e.g., at least 500, at least 600, at least 700, at least 800, or at least 900.

[0031] The paraffin oil plasticizer can also have a high viscosity. The kinematic viscosity can be measured, for example, using the procedures of Chinese Standard BG/T 265-1988. The paraffin oil plasticizer can have a kinematic viscosity at 40 °C that is within the range from 400 mm²/second to 1000 mm²/second, e.g., from . 400 to 700 mm²/second, from 500 to 800 mm²/second, from 600 to 900 mm²/second, from 700 to 1000 mm²/second, from 400 to 500 mm²/second, from 500 to 600 mm²/second, from 600 to 700 mm²/second, from 700 to 800 mm²/second, from 800 to 900 mm²/second, or from 900 to 1000 mm²/second. In terms of upper limits, the plasticizer can have a kinematic viscosity that is less than 1000 mm²/second, e.g., less

than 900 mm²/second, less than 800 mm²/second, less than 700 mm²/second, less than 600 mm²/second, or less than 500 mm²/second. In terms of lower limits, the plasticizer can have a kinematic viscosity that is greater than 400 mm²/second, e.g., greater than 500 mm²/second, greater than 600 mm²/second, greater than 700 mm²/second, greater than 800 mm²/second, or greater than 900 mm²/second.

[0032] It has been found that the use of a tackifier having a low molecular weight and viscosity advantageously (partially) offsets the high molecular weight and viscosity of the plasticizer. The inventors have found that if the overall viscosity of the HMPSA is too high, then the processability of the adhesive can suffer. In particular, an adhesive with a higher viscosity can be more difficult to use in standard compounding and coating processes associated with adhesive label production. In general, as the viscosity of an adhesive is lowered, the processability of the adhesive improves, and the resulting adhesive coating layer is more uniform and consistent.

[0033] Many common linear aliphatic hydrocarbon tackifiers have weight average molecular weights that are within the range from 1000 to 4000. The inventors have found that by using a cycloaliphatic hydrocarbon tackifier resin in the HMPSA, the high molecular weight linear aliphatic hydrocarbon can be beneficially avoided. The cycloaliphatic hydrocarbon tackifier can have a lower weight average molecular weight that is within the range from 300 to 1000 or from 300 to 800, e.g., from 300 to 600, from 400 to 700, from 500 to 800, from 300 to 400, from 400 to 500, from 500 to 600, from 600 to 700, or from 700 to 800. In terms of upper limits, the tackifier can have a weight average molecular weight that is less than 800, e.g., less than 700, less than 600, less than 500, or less than 400. In terms of lower limits, the tackifier can have a weight average molecular weight that is at least 300, e.g., at least 400, at least 500, at least 600, or at least 700. As an additional benefit, the relatively high polarity and steric hindrance effects of the cycloaliphatic hydrocarbon chemical structure also work to reduce oil migration within and between the layers of an associated label. Also, hydrogenation of the resin results in an adhesive layer and label that has reduced color, odor, and char particles.

[0034] The amount of the cycloaliphatic hydrocarbon tackifier within the HMPSA composition can be within the range from 15 to 65 weight%, e.g., from 15 to 45, from 20 to 50, from 25 to 55, from 30 to 60, or from 35 to 65 weight%. The amount of the cycloaliphatic hydrocarbon tackifier within the HMPSA composition can be within the range from 30 to 50 weight%, e.g., from 30 to 42, from 32 to 44, from 34 to 46, from 36 to 48, or from 38 to 50 weight%. In terms of upper

limits, the amount of the cycloaliphatic hydrocarbon tackifier within the HMPSA composition can be less than 70, less than 65, less than 60, less than 55, less than 50, less than 45, or less than 40 weight%. In terms of lower limits, the amount of the cycloaliphatic hydrocarbon tackifier within the HMPSA composition can be at least 10, at least 15, at least 20, at least 25, at least 30, at least 35, or at least 40 weight%.

[0035] The HMPSA may optionally comprise a polyethylene wax. The optional polyethylene wax of the HMPSA can function to increase the hydrophobicity of the adhesive. This increased hydrophobicity can assist in improving the resistance of the adhesive to water whitening, and the ability of the adhesive to be cleanly removed or repositioned. The particular polyethylene wax can also be selected to further reduce the overall viscosity of the HMPSA, and to have minimal impact on the transparency of the adhesive.

[0036] The polyethylene wax can be selected to have a particular hardness value. The hardness value can be measured with, for example, a penetration test as in the American Society for Testing and Materials (ASTM) standard procedure ASTM D5. The hardness in this procedure is defined as the distance in tenths of a millimeter that a standard needle penetrates a sample of the tested material. The polyethylene wax can have a hardness value within the range from 3 to 10, e.g., from 3 to 6, from 4 to 7, from 5 to 8, from 6 to 9, from 7 to 10, from 3 to 4, from 4 to 5, from 5 to 6, from 6 to 7, from 7 to 8, from 8 to 9, or from 9 to 10. In terms of upper limits, the polyethylene wax can have a hardness value that is less than 10, e.g., less than 9, less than 8, less than 7, less than 6, less than 5, or less than 4. In terms of lower limits, the polyethylene wax can have a hardness value that is at least 3, e.g., at least 4, at least 5, at least 6, at least 7, at least 8, or at least 9.

[0037] The polyethylene wax can have a relatively low viscosity, such as a dynamic viscosity as measured by a Brookfield viscometer. The polyethylene wax can have a dynamic viscosity at 140 °C within the range from 150 centipoise (cps) to 500 cps, e.g., from 150 to 300 cps, from 250 to 400 cps, from 350 to 500 cps, from 150 to 200 cps, from 200 to 250 cps, from 250 to 300 cps, from 300 to 350 cps, or from 350 to 400 cps. In terms of upper limits, the polyethylene wax can have a dynamic viscosity at 140 °C that is less than 500 cps, less than 450 cps, less than 400 cps, less than 350 cps, less than 300 cps, less than 250 cps, or less than 200 cps. In terms of lower limits, the polyethylene wax can have a dynamic viscosity at 140 °C that is at least 150

cps, e.g., at least 200 cps, at least 250 cps, at least 300 cps, at least 350 cps, at least 400 cps, or at least 450 cps.

[0038] The polyethylene wax can also be selected to have a particular pour point as measured by the standard procedure ASTM D5949. The pour point is defined as the temperature at which a liquid becomes semi-solid and loses its flow characteristics. The polyethylene wax can have a pour point that is greater than 90 °C, greater than 91 °C, greater than 92 °C, greater than 93 °C, greater than 94 °C, greater than 95 °C, greater than 96 °C, greater than 97 °C, greater than 98 °C, greater than 99 °C, greater than 100 °C, greater than 101 °C, greater than 102 °C, greater than 103 °C, greater than 104 °C, greater than 105 °C, greater than 106 °C, greater than 107 °C, greater than 108 °C, greater than 109 °C, or greater than 110 °C. In some embodiments, the polyethylene wax has a pour point that is greater than 100 °C.

[0039] The amount of the polyethylene wax within the HMPSA composition can be within the range from 0 to 5 weight%, e.g., from 0 to 3, from 0.5 to 3.5, from 1 to 4, from 1.5 to 4.5, or from 2 to 5 weight%. The amount of the polyethylene wax within the HMPSA composition can be within the range from 0 to 2 weight%, e.g., from 0 to 1.2, from 0.2 to 1.4, from 0.4 to 1.6, from 0.6 to 1.8, or from 0.8 to 2 weight%. In terms of upper limits, the amount of the polyethylene wax within the HMPSA composition can be less than 5, less than 4, less than 3, less than 2, less than 1.5, less than 1, or less than 0.5 weight%. In terms of lower limits, the amount of the polyethylene wax within the HMPSA composition can be zero or at least 0.5, at least 1, at least 1.5, at least 2, or at least 2.5 weight%.

[0040] The overall viscosity of the HMPSA can be such that the dynamic viscosity of the adhesive at 140 °C as measured by a Brookfield viscometer is within the range from 10,000 cps to 20,000 cps, e.g., from 10,000 to 14,000 cps, from 12,000 to 16,000 cps, from 14,000 to 18,000 cps, from 16,000 to 20,000 cps, from 10,000 to 12,000 cps, from 12,000 to 14,000 cps, from 14,000 to 16,000 cps, from 16,000 to 18,000 cps, or from 18,000 to 20,000 cps. In terms of upper limits, the HMPSA can have a dynamic viscosity at 140 °C that is less than 20,000 cps, e.g., less than 18,000 cps, less than 16,000 cps, less than 14,000 cps, or less than 12,000 cps. In terms of lower limits, the HMPSA can have a dynamic viscosity at 140 °C that at least 10,000, e.g., at least 12,000 cps, at least 14,000 cps, at least 16,000 cps, or at least 18,000 cps.

[0041] The HMPSA can be formulated as above to have a slightly white or colorless appearance. The HMPSA also can be formulated to have a high degree of clarity and

transparency. This can provide a benefit to the adhesive or an associated label in applications in which a clear or transparent adhesive or label is desired. For example, clear labels can be used with a variety of different attachment surfaces or materials to allow the color or texture of these attachment surfaces to remain visible through the label. Clear or transparent adhesives or labels can also be used with clear or transparent containers. Such “clear on clear” labeling is common in, for example, the beverage industry for use with glass or plastic bottles. With clear on clear labeling, any printing on the label tends to appear as if the printing is directly on the container itself, due in part to the transparency and lack of color of the adhesive. To produce an adhesive with the desired lack of color, the tackifier resin, plasticizer oil, wax, fillers, and other ingredients are each selected to have light to no coloration and/or good solubility in the adhesive composition.

[0042] The clarity and transparency of the HMPSA can be measured as a haze value according to the standard protocol ASTM D1003, or an opacity contrast ratio according to the standard protocol ASTM D2805. The haze value is defined as the percent of transmitted light scattered by a specimen responsible for the reduction in contrast of objects viewed through it. The haze value of the HMPSA can be, for example, less than 10, less than 9, less than 8, less than 7, less than 6, less than 5, less than 4, less than 3, less than 2, or less than 1. In some embodiments, the HMPSA has a haze value of less than 5. The opacity contrast ratio is defined as the ratio of the reflectance of a film on a black substrate to that of an identical film on a white substrate. The opacity contrast value of the HMPSA can be, for example, less than 40, less than 35, less than 30, less than 25, less than 20, less than 15, less than 10, or less than 5. In some embodiments, the HMPSA has an opacity contrast ratio that is less than 20.

[0043] Another advantage of the HMPSA formulation is a whiteness, clarity, and transparency that is not significantly affected by changes in temperature or humidity. For example, the haze value and opacity contrast ratio can each independently change by less than 30%, less than 28%, less than 26%, less than 24%, less than 22%, less than 20%, less than 18%, less than 16%, less than 14%, less than 12%, less than 10%, less than 8%, less than 6%, less than 4%, or less than 2% upon heating of the adhesive to 65 °C for 1 hour. The heating can include contacting the adhesive with water that is heated to 65 °C. The heating can include submerging the adhesive in 65 °C water.

[0044] The elements of the HMPSA composition can be selected to satisfy food contact requirements and be generally classified as food safe. For example, the use of hydrogenated tackifiers and food-grade paraffin oils can enable the HMPSA to be a food safe adhesive.

[0045] The present invention also relates to labels that include a hotmelt pressure sensitive adhesive of the present invention. The labels include a layer of facestock for receiving printed indicia, and a layer of hotmelt pressure sensitive adhesive having a composition as described above. The labels can also include one or more facestock layers, one or more optional print layers, one or more adhesive layers, and optionally a liner layer. The present subject matter may be utilized in labels free of print, but in many embodiments, the labels comprise one or more regions of print.

[0046] FIG. 2 illustrates a multilayer label in accordance with an embodiment. Shown is label 200 that includes a facestock layer 201, an HMPSA layer 202, and a liner layer 203. The HMPSA layer is disposed on a surface 204 of the facestock layer that is closer to the liner layer. The opposite surface 205 of the facestock layer can be configured to receive printed indicia. This optional indicia can be printed directly onto the surface 205; embedded within any of layers 201, 202, or 203; or printed on any other surface of the label 200. The layers shown in FIG. 2 can be positioned directly adjacent to one another as depicted, or can have one or more additional layers in between them. Additional layers can include, for example, one or more coating layers, support layers, print layers, reflective layers, laminate layers, or others. Any one or more of the layers shown can also include two or more sublayers, each with different compositions, configurations, and functions.

[0047] The facestock can include, for example, paper facestock, cardboard facestock, plastic facestock, a multilayer laminated facestock including both paper and plastic layers, or any other materials that are commonly used in the industry. The multilayer laminate facestock can include a paper layer overlying a plastic layer. The plastic layer of the multilayer laminate facestock can be extruded or otherwise coated onto the paper layer. The paper layer can include, for example, high gloss paper, semi-gloss paper, lithographic paper, or electronic data processing (EDP) paper; and can be configured for use in, for example, multi-color printing, typewriter printing, or inkjet printing. The plastic layer can include, for example, polyesters, such as PET; polyolefins, such as polypropylene (PP), ethylene-propylene copolymers, polyethylene (PE); and other materials. Other polymeric film materials include urethane based polymers such as polyether

urethane and polyester urethane; amide based polymers including polyether polyamide copolymers; acrylic based polymers including a polyacrylate, and ethylene/vinyl acetate copolymer; polyester based polymers including a polyether polyester; a vinyl chloride; a vinylidene chloride; a polystyrene; a polyacrylonitrile; a polycarbonate; a polyimide; or the like. The facestock can include a flexible facestock. The facestock can include a transparent polymeric film. In certain applications, it can be useful to utilize "shrink" films or oriented films as a facestock layer. The present subject matter includes, for example, biaxially oriented films such as PET as a facestock layer.

[0048] In some embodiments, the label further includes print disposed on the layer of facestock. The print can include layers or regions of ink, dyes, pigments, or like materials. As will be understood, "dye" and like terms mean a visible light absorbing compound present in a molecularly dispersed or dissolved form. "Pigment" and like terms mean a visible light absorbing material or compound that is present in a non-molecularly dispersed or particulate form. "Ink" and like terms means a coatable or printable formulation containing a dye and/or pigment. Although the present subject matter is largely directed toward labels including visually perceptible print, it is contemplated that the labels may include print that is exclusively or primarily indicative under UV light or other conditions.

[0049] The HMPSA layer can be applied directly adjacent to, and in contact with, the facestock. There can be intervening layers between the HMPSA layer and the facestock. The label can include two or more layers of HMPSA and/or facestock. The HMPSA layer of the label can be coated onto the facestock with a coat weight of, for example, from 5 grams per square meter (gsm) to 30 gsm. The adhesive layer coat weight can be from 6 gsm to 20 gsm, from 8 gsm to 20 gsm, from 22 gsm to 30 gsm, from 16 gsm to 40 gsm. In some embodiments, the adhesive layer coat weight is within the range from 5 gsm to 40 gsm. In terms of upper limits, the adhesive layer coat weight can be less than 40 gsm, e.g., less than 35 gsm, less than 30 gsm, less than 25 gsm, less than 20 gsm, less than 15 gsm, or less than 10 gsm. In terms of lower limits, the adhesive layer coat weight can be at least 5 gsm, e.g., at least 10 gsm, at least 15 gsm, at least 20 gsm, at least 25 gsm, at least 30 gsm, or at least 35 gsm.

[0050] The present subject matter can include the incorporation of one or more clear or transparent layers in any of the label constructions described herein. The present subject matter can also include the incorporation of one or more metallic layers or metal foils in any of the label

constructions described herein. It is also contemplated that the label constructions can also include combinations of one or more transparent layers and one or more metallic layers. In some embodiments, the label is a clear on clear label having a laminate composition that includes a transparent biaxially oriented polypropylene (BOPP) film, a transparent HMPSA layer, and a transparent PET liner.

[0051] In some embodiments, the label further includes a liner disposed on the layer of HMPSA. A releasable liner can be positioned adjacent to the adhesive layer such that the adhesive layer is disposed, or sandwiched, directly or indirectly between the bottom surface of the facestock and the releasable liner. The releasable liner may function as a protective cover such that the release liner remains in place until the label is ready for attachment to an object. If a liner or release liner is included in the label, a wide array of materials and configurations can be used for the liner. In many embodiments, the liner is a paper or paper-based material. In many other embodiments, the liner is a polymeric film of one or more polymeric materials. Typically, at least one face of the liner is coated with a release material such as a silicone or silicone-based material. As will be appreciated, the release coated face of the liner is placed in contact with the otherwise exposed face of the adhesive layer. Prior to application of the label to a surface of interest, the liner is removed to thereby expose the adhesive face of the label. The liner can be in the form of a single sheet. Alternatively, the liner can be in the form of multiple sections or panels.

[0052] Other additives can be added to one or more of the HMPSA, facestock, or liner layers to obtain a certain desired characteristic. These additives can include, for example, one or more waxes, surfactants, talc, powdered silicates, filler agents, defoamers, colorants, antioxidants, UV stabilizers, luminescents, crosslinkers, buffer agents, anti-blocking agents, wetting agents, matting agents, antistatic agents, acid scavengers, flame retardants, processing aids, extrusion aids, and others.

[0053] The present invention also relates to labeled containers that include a hotmelt pressure sensitive adhesive of the present invention. The labeled containers include a container defining an outer surface, and a label as described above that is adhered to the outer face of the container. In some embodiments, the container is a bottle. The outer surface to which the HMPSA is adhered can include a wide range of substrates. The outer surface can include glass, plastic,

wood, metal, combination of these, and other materials. In some embodiments, the outer surface of the container includes glass.

[0054] In some embodiments, the outer surface of the container includes plastic. The outer surface can include or be formed from any suitable polymer or mixture of polymers. The polymer or mixture of polymers can include, for example, PET, recycled polyethylene terephthalate (rPET), high density polyethylene (HDPE), polyvinyl chloride (PVC), poly lactic acid (PLA), cellulose, biopolymer films, low density polyethylene (LDPE), PP, polystyrene (PS), polyesters, or other types of polymers or plastics. In some embodiments, the plastic includes PET.

[0055] Although labels can generally be removed from containers, the outer surface of the container can retain a portion of the adhesive used to adhere the label to the container. This adhesive residue can contaminate or interfere with subsequent container operations such as later washings, relabeling, or container recycling. In some embodiments, the provided label can be removed from the outer surface while substantially all of the adhesive remains disposed and/or retained with the label rather than remaining with the outer surface.

[0056] The present invention also relates to methods of applying a label to a container. The methods include providing a container defining an outer surface, and a label in accordance with an embodiment. The methods further include adhering the label to the outer surface of the container, thereby applying the label to the container.

[0057] The labels can be adhered to one or more containers or articles in a batch, continuous, or semi-continuous fashion. Prior to application, one or more liners can be removed from the labels to thereby expose the adhesive face of the labels. The adhesive face and label is then contacted with the container(s) or article(s) and the labels applied thereto. Adhering may also include one or more operations of pressing or otherwise applying a pressing force against the label to promote contact and/or adhesion with the container; activating and/or curing of the adhesive such as by heating and/or exposure to UV light; and/or drying operations.

[0058] The following embodiments are contemplated. All combinations of features and embodiment are contemplated.

[0059] Embodiment 1: A hotmelt pressure sensitive adhesive comprising: a styrene-isoprene-styrene copolymer; a tackifier comprising a hydrogenated cycloaliphatic hydrocarbon resin; a plasticizer comprising a paraffin oil having a kinematic viscosity at 40 °C within the range from

400 to 1000 mm²/second; and less than 5 weight% of a polyethylene wax.

[0060] Embodiment 2: An embodiment of embodiment 1, wherein the tackifier has a weight average molecular weight ranging from 300 to 1000.

[0061] Embodiment 3: An embodiment of any one of the embodiments of embodiment 1 or 2, wherein the plasticizer has a number average molecular weight within the range from 400 to 1000.

[0062] Embodiment 4: An embodiment of embodiment 3, wherein the weight average molecular weight of the tackifier is within 10% of the number average molecular weight of the plasticizer.

[0063] Embodiment 5: An embodiment of any one of the embodiments of embodiment 1 – 4, wherein the concentration of the styrene-isoprene-styrene copolymer in the hotmelt pressure sensitive adhesive is within the range from 15 to 65 weight%, wherein the concentration of the tackifier in the hotmelt pressure sensitive adhesive is within the range from 15 to 65 weight%, and wherein the concentration of the plasticizer in the hotmelt pressure sensitive adhesive is within the range from 5 to 35 weight%.

[0064] Embodiment 6: An embodiment of any one of the embodiments of embodiment 1 – 4, wherein the concentration of the styrene-isoprene-styrene copolymer in the hotmelt pressure sensitive adhesive is within the range from 25 to 55 weight%, wherein the concentration of the tackifier in the hotmelt pressure sensitive adhesive is within the range from 25 to 55 weight%, wherein the concentration of the plasticizer in the hotmelt pressure sensitive adhesive is within the range from 15 to 25 weight%, and wherein the concentration of the polyethylene wax in the hotmelt pressure sensitive adhesive is less than 2 weight%.

[0065] Embodiment 7: An embodiment of any one of the embodiments of embodiment 1 – 6, wherein the styrene-isoprene-styrene copolymer has a diblock grade of less than 30 weight%.

[0066] Embodiment 8: An embodiment of any one of the embodiments of embodiment 1 – 7, wherein the styrene-isoprene-styrene copolymer has a styrene content of less than 25 weight%.

[0067] Embodiment 9: An embodiment of any one of the embodiments of embodiment 1 – 8, wherein the plasticizer has a kinematic viscosity at 40 °C within the range from 400 to 700 mm²/second.

[0068] Embodiment 10: An embodiment of any one of the embodiments of embodiment 1 – 9, wherein the polyethylene wax has a dynamic viscosity at 140 °C within the range from 150 to

500 cps.

[0069] Embodiment 11: An embodiment of any one of the embodiments of embodiment 1 – 10, wherein the polyethylene wax has a pour point of greater than 100 °C.

[0070] Embodiment 12: An embodiment of any one of the embodiments of embodiment 1 – 11, wherein the hotmelt pressure sensitive adhesive has a haze value of less than 5.

[0071] Embodiment 13: An embodiment of any one of the embodiments of embodiment 1 – 12, wherein the hotmelt pressure sensitive adhesive has an opacity contrast ratio of less than 20.

[0072] Embodiment 14: An embodiment of embodiment 12, wherein the haze value changes by less than 20% upon heating of the hotmelt pressure sensitive adhesive to 65 °C for 1 hour.

[0073] Embodiment 15: An embodiment of embodiment 13, wherein the opacity contrast ratio changes by less than 20% upon heating of the hotmelt pressure sensitive adhesive to 65 °C for 1 hour.

[0074] Embodiment 16: An embodiment of any one of the embodiments of embodiment 1 – 15, wherein the hotmelt pressure sensitive adhesive has a dynamic viscosity at 140 °C within the range from 10,000 to 20,000 cps.

[0075] Embodiment 17: A label comprising a facestock capable of receiving printed indicia; and a hotmelt pressure sensitive adhesive comprising the hotmelt pressure sensitive adhesive of any one of the embodiments of embodiment 1 – 16.

[0076] Embodiment 18: An embodiment of embodiment 17, further comprising a liner disposed on the layer of hotmelt pressure sensitive adhesive.

[0077] Embodiment 19: An embodiment of any one of the embodiments of embodiment 17 or 18, wherein the label has a machine direction length and a cross direction length, and wherein the machine direction length and cross direction length each change by less than 2% upon storage of the label at 85% relative humidity for four days at greater than 65 °C.

[0078] Embodiment 20: A labeled container comprising a container having an outer surface; and a label of any one of the embodiments of embodiment 17 – 19 adhered to the outer face of the container.

[0079] Embodiment 21: An embodiment of embodiment 20, wherein the outer surface of the container comprises glass, polyethylene terephthalate, or other plastic.

[0080] Embodiment 22: An embodiment of any one of the embodiments of embodiment 20 or 21, wherein the container is a bottle.

[0081] Embodiment 23: An embodiment of any one of the embodiments of embodiment 20 – 22, wherein the label can be substantially completely removed from the container by peeling.

[0082] Embodiment 24: A method of applying a label to a container, the method comprising providing a container defining an outer surface; providing a label of any one of the embodiments of embodiment 17 – 19; and adhering the label to the outer surface of the container, thereby applying the label to the container.

[0083] Embodiment 25: An embodiment of embodiment 24, wherein the outer surface of the container comprises glass, polyethylene terephthalate, or other plastic.

[0084] Embodiment 26: An embodiment of any one of the embodiments of embodiment 24 or 25, wherein the label can be substantially completely removed from and reapplied to the container within the first 8 hours after adhering at a temperature above 5 °C.

[0085] The present invention will be better understood in view of the following non-limiting examples.

Examples

[0086] Eight HMPSA compositions were prepared according to the formulations listed below in Table 1. The HMPSAs were tested for physical and performance characteristics, e.g., swelling, dynamic viscosity, and processing performance. The results are also provided in Table 1.

Table 1: Clear on Clear HMPSA Formulations								
Component, wt%	Comp. Ex. A COC19	Comp. Ex. B COC30	Ex. 1 COC47	Ex. 2 COC38	Ex. 3 COC48	Comp. Ex. C COC21	Comp. Ex. D COC22	Ex. 4 F65
Jusage SIS1220 copolymer	40	40	40	40	40.5	39	39	40
Eastman C100L tackifier (MW 1079)	40							
Eastman C100W tackifier (MW 1700)		40						
Eastman C100R tackifier (MW 1050)						39	39	
Luhua HD1100 tackifier (MW 606)			39		40			40
Exxon E5400 tackifier (MW 666)				39				
PIB950 plasticizer (MW 724; visc. 7200)	19					19	19	
PIB680 plasticizer (MW 603; visc. 1700)		19						
KP6030 plasticizer (MW 511; visc. 466)			18.5	18	18.5			20
Polyethylene wax AC-6			1.5	2				
Antioxidant B225	1	1	1	1	1	1	1	1
Performance Characteristics								
Swelling in machine direction	0.31%	0.33%	0.53%	--	--	--	--	--
HMPSA dynamic Visc. at 175 °C (cps)	42750	36375	13500	14400	12100	84800	>84800	12100
Processability	Poor	Poor	Excellent	Excellent	Excellent	Poor	Poor	Excellent

[0087] Labels were prepared using the HMPSAs of Comparative Examples A and B and Example 1 and were tested for swelling. The label that utilized the HMPSA of Example 1 (and those that employed Comparative Examples A and B) demonstrated very good swelling results. As discussed above, adhesives with reduced swelling have greater structural integrity and can also exhibit less oil migration than adhesives that have a greater tendency to swell. The label that utilized the HMPSA of Example 1 also demonstrated a superior combination of performance characteristics, e.g., water whitening resistance, repositionability, and/or optical clarity. Importantly, the HMPSA of Example 1 had a lower viscosity, was easy to process, and led to a high quality label. In contrast, the HMPSA of Comparative Examples A and B demonstrated a much higher viscosity, which led to difficulty in processing and a lower quality label.

[0088] As shown in Table 1, formulations of Examples 1 – 4 and 8 employ a plasticizer having a kinematic viscosity at 40 °C within the range of 400 and 1000 mm²/second. These

formulations provide, *inter alia*, hotmelt PSAs having advantageous combinations of performance characteristics, along with excellent processability. These example adhesives have a high level of water whitening resistance, good removability, optically clarity, and low swelling and oil migration. Importantly, Examples 1 – 4 demonstrate low dynamic viscosities, e.g., in the range from 10000 – 20000 centipoise, which provides for the formation of high quality coating layers, i.e., excellent processability. In contrast, Comparative Examples A – D demonstrate much higher dynamic viscosities (much higher than 20000 centipoise, and in some cases are greater than 80000 centipoise). These Comparative Examples, at least in part due to the high viscosity plasticizer, demonstrated poor processability.

[0089] Also, as shown in Table 1, the HMPSA formulations of Examples 1 – 4 each include a tackifier having a molecular weight within the preferred range of 300 – 800. These relatively low tackifier molecular weights can serve to partially offset the number average molecular weights of the plasticizers, which further contributes the lower overall dynamic viscosities, e.g., within the advantageous range of 10000 – 20000 centipoise. In contrast, the formulations of Comparative Examples A – D employ a tackifier having a number average molecular weight greater than 1000. The resultant HMPSAs have much higher dynamic viscosities, e.g., greater than 35000 centipoise, which adds difficulty to processing steps such as compounding and coating. Thus, Examples 1 – 4 and Comparative Examples A – D demonstrate the importance of combining a low weight average molecular weight tackifier with a high number average molecular weight plasticizer in formulating an adhesive that simultaneously meets the desired properties of low swelling, low oil migration, and low viscosity.

[0090] In sum, the data in Table 1 show that the formulations of the Comparative Examples employ high viscosity plasticizers (and optionally plasticizers and/or a tackifiers) that are outside of the viscosity and/or molecular weight ranges discussed herein. These Comparative Examples have undesirable physical and/or performance characteristics. These data demonstrate the importance and criticality of the aforementioned components.

[0091] While the invention has been described in detail, modifications within the spirit and scope of the invention will be readily apparent to those of skill in the art. In view of the foregoing discussion, relevant knowledge in the art and references discussed above in connection with the Background and Detailed Description, the disclosures of which are all incorporated herein by reference. In addition, it should be understood that aspects of the invention and

portions of various embodiments and various features recited below and/or in the appended claims may be combined or interchanged either in whole or in part. In the foregoing descriptions of the various embodiments, those embodiments which refer to another embodiment may be appropriately combined with other embodiments as will be appreciated by one of skill in the art. 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.

We claim:

1. A hotmelt pressure sensitive adhesive comprising:
 - a styrene-isoprene-styrene copolymer;
 - a tackifier comprising a hydrogenated cycloaliphatic hydrocarbon resin;
 - a plasticizer comprising a paraffin oil having a kinematic viscosity at 40 °C within the range from 400 to 1000 mm²/second; and
 - less than 5 weight% of a polyethylene wax.
2. The hotmelt pressure sensitive adhesive of claim 1, wherein the tackifier has a weight average molecular weight ranging from 300 to 1000.
3. The hotmelt pressure sensitive adhesive of claim 1 or 2, wherein the plasticizer has a number average molecular weight within the range from 400 to 1000.
4. The hotmelt pressure sensitive adhesive claim 3, wherein the weight average molecular weight of the tackifier is within 10% of the number average molecular weight of the plasticizer.
5. The hotmelt pressure sensitive adhesive of any of claims 1-4, wherein the concentration of the styrene-isoprene-styrene copolymer in the hotmelt pressure sensitive adhesive is within the range from 15 to 65 weight%, wherein the concentration of the tackifier in the hotmelt pressure sensitive adhesive is within the range from 15 to 65 weight%, and wherein the concentration of the plasticizer in the hotmelt pressure sensitive adhesive is within the range from 5 to 35 weight%.
6. The hotmelt pressure sensitive adhesive of any of claims 1-4, wherein the concentration of the styrene-isoprene-styrene copolymer in the hotmelt pressure sensitive adhesive is within the range from 25 to 55 weight%, wherein the concentration of the tackifier in the hotmelt pressure sensitive adhesive is within the range from 25 to 55 weight%, wherein the concentration of the plasticizer in the hotmelt pressure sensitive adhesive is within the range from 15 to 25 weight%, and wherein the concentration of the polyethylene wax in the hotmelt pressure sensitive adhesive is less than 2 weight%.

7. The hotmelt pressure sensitive adhesive of any of claims 1-6, wherein the styrene-isoprene-styrene copolymer has a diblock grade of less than 30 weight%.
8. The hotmelt pressure sensitive adhesive of any of claims 1-7, wherein the styrene-isoprene-styrene copolymer has a styrene content of less than 25 weight%.
9. The hotmelt pressure sensitive adhesive of any of claims 1-8, wherein the plasticizer has a kinematic viscosity at 40 °C within the range from 400 to 700 mm²/second.
10. The hotmelt pressure sensitive adhesive of any of claims 1-9, wherein the polyethylene wax has a dynamic viscosity at 140 °C within the range from 150 to 500 cps.
11. The hotmelt pressure sensitive adhesive of any of claims 1-10, wherein the polyethylene wax has a pour point of greater than 100 °C.
12. The hotmelt pressure sensitive adhesive of any of claims 1-11, wherein the hotmelt pressure sensitive adhesive has a haze value of less than 5.
13. The hotmelt pressure sensitive adhesive of claim 12, wherein the haze value changes by less than 20% upon heating of the hotmelt pressure sensitive adhesive to 65 °C for 1 hour.
14. The hotmelt pressure sensitive adhesive of any of claims 1-13, wherein the hotmelt pressure sensitive adhesive has an opacity contrast ratio of less than 20.
15. The hotmelt pressure sensitive adhesive of claim 14, wherein the opacity contrast ratio changes by less than 20% upon heating of the hotmelt pressure sensitive adhesive to 65 °C for 1 hour.
16. The hotmelt pressure sensitive adhesive of any of claims 1-15, wherein the hotmelt pressure sensitive adhesive has a dynamic viscosity at 140 °C within the range from 10,000 to 20,000 cps.
17. A label comprising:
a facestock capable of receiving printed indicia; and

a hotmelt pressure sensitive adhesive comprising the hotmelt pressure sensitive adhesive of any of claims 1-16.

18. The label of claim 17, further comprising:

a liner disposed on the layer of hotmelt pressure sensitive adhesive.

19. The label of claims 17 or 18, wherein the label has a machine direction length and a cross direction length, and wherein the machine direction length and cross direction length each change by less than 2% upon storage of the label at 85% relative humidity for four days at greater than 65 °C.

20. A labeled container comprising:

a container having an outer surface; and

a label of any of claims 17-19 adhered to the outer face of the container.

21. The labeled container of claim 20, wherein the outer surface of the container comprises glass, polyethylene terephthalate, or other plastic.

22. The labeled container of claim 20 or 21, wherein the container is a bottle.

23. The labeled container of any of claims 20-22, wherein the label can be substantially completely removed from the container by peeling.

24. A method of applying a label to a container, the method comprising:

providing a container defining an outer surface;

providing a label of any of claims 17-19; and

adhering the label to the outer surface of the container, thereby applying the label to the container.

25. The method of claim 24, wherein the outer surface of the container comprises glass, polyethylene terephthalate, or other plastic.

26. The method of claim 24 or 25, wherein the label can be substantially completely removed from and reapplied to the container within the first 8 hours after adhering at a temperature above 5 °C.

FIG. 1

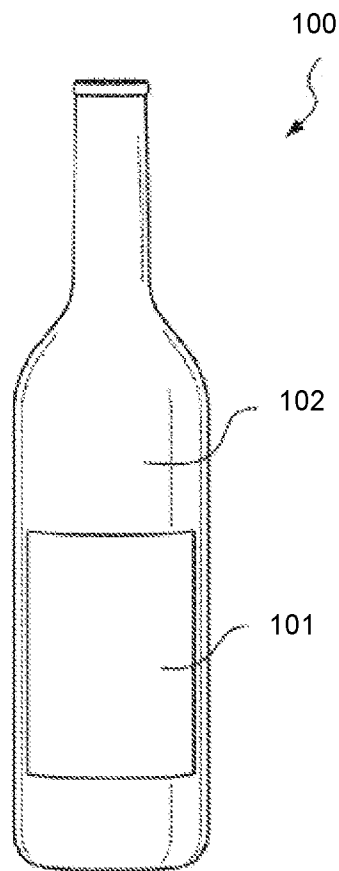
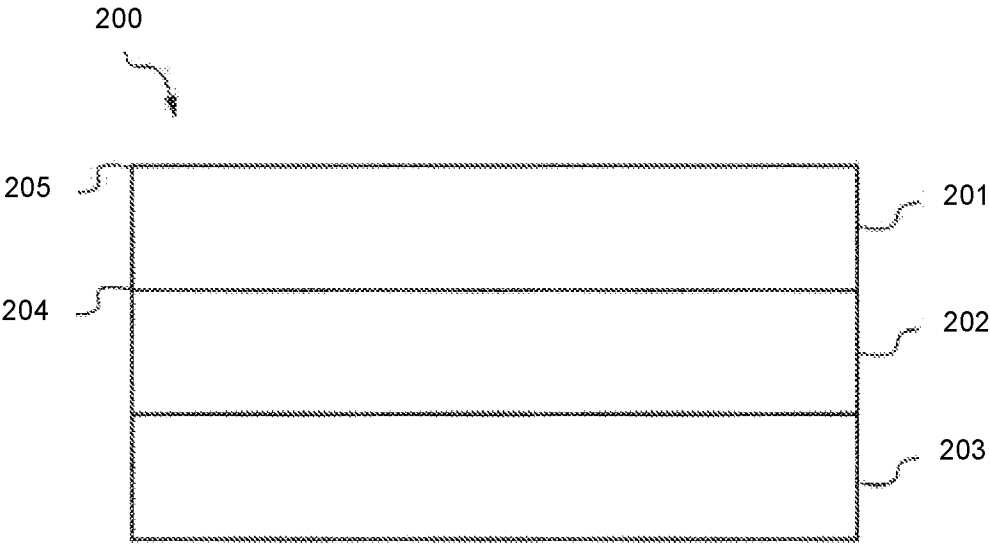


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/073083

A. CLASSIFICATION OF SUBJECT MATTER

C09J 125/10(2006.01)i; C09J 109/06(2006.01)i; B32B 7/12(2006.01)i; B32B 27/28(2006.01)i

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)

C09J125; C09J109; B32B7; B32B27

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

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

CNKI, WPI, CNABS, SIPOABS; pressure sensitive adhesive, styrene, isoprene, SIS, cycloaliphatic, alicyclic, tackifier, plasticizer, polyethylene wax

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5939483 A (FULLER LICENSING & FINANCING INC H B) 17 August 1999 (1999-08-17) the whole document	1-26
A	US 4983674 A (MITSUI PETROCHEM IND CO LTD) 08 January 1991 (1991-01-08) the whole document	1-26
A	US 2014335299 A (3M INNOVATIVE PROPERTIES CO) 13 November 2014 (2014-11-13) the whole document	1-26



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

“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

03 November 2017

Date of mailing of the international search report

15 November 2017

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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