form, or wound into roll form; self-adhesive sheets, e.g., note sheets, labels, sign sheeting, etc.; container closures; etc. A variety of adhesive formulations, offering a variety of performance, cost, and production criteria, have come to be used. Illustrative examples of materials from which PSA are made include acrylic polymers, thermoplastic elastomers, natural rubbers and synthetic rubbers, nonelastomeric thermoplastic polymers, etc.

Illustrative examples of methods for making PSA coatings or forming them on a desired surface include extrusion and solvent coating. Selection of a suitable method will be dependent in part upon the nature of the PSA formulation being used, nature of the substrate on which the coating is to be formed, available equipment and materials, etc.

Though various methods of making hot melt coatings are known, they are capable of producing satisfactory coating quality, i.e., as continuous as desired, only of coatings above certain thicknesses. The need exists to produce, at higher speeds, high quality melt coatings having lower thickness.

Summary

The present ~~invention~~ disclosure provides articles with thin caliper melt coatings of high molecular weight, high viscosity materials and methods of making such articles. In some embodiments, particular advantages are achieved with PSA coatings.

Articles of the disclosure ~~invention~~ can be made in a variety of configurations with a variety of different melt coated formulations. Illustrative embodiments include pressure sensitive coatings and hot melt adhesive coatings. Illustrative examples of formulations that can be used in the present disclosure ~~invention~~ include acrylic polymers, thermoplastic elastomers, natural rubbers, synthetic rubbers, and nonelastic thermoplastic polymers.

Briefly summarizing, articles of the disclosure ~~invention~~ comprise a substrate having a first surface and a melt coated layer having a first major surface and a second major surface, the first major surface of the melt coated layer being disposed upon the first surface of the substrate. The melt coated layer is substantially continuous and exhibits desired properties, e.g., is a PSA, provides hot melt adhesion, etc. In accordance with the present disclosure ~~invention~~, the melt coated layer is thinner than previously available coatings of such high molecular weight, high viscosity materials.

Melt coated layers of the disclosure ~~invention~~ may be formed from melt compositions selected from the group consisting of:

(a) one or more acrylic polymers having a collective molecular weight of at least about 200,000, wherein the composition, is free of solvents and contains no more than about 1% by weight of gelled acrylic polymer;

(b) one or more thermoplastic elastomers having a collective melt viscosity greater than about 20,000 cP, measured at any temperature suitable for hot-melt coating the composition and at shear rates less than 100 sec^{-1} or frequencies less than 100 rad/sec;

(c) one or more natural rubbers or synthetic rubbers, none of which is a thermoplastic elastomer, having a collective molecular weight of at least about 200,000 g/mol and a collective melt viscosity greater than about 50,000 cP, measured at any temperature suitable for hot-melt coating the composition and at shear rates less than 100 sec^{-1} or frequencies less than 100 rad/sec; and

(d) one or more nonelastomeric thermoplastic polymers having a collective molecular weight of from about 50,000 to about 3,000,000 g/mol wherein the composition is free of solvents. The term collective is used herein to express that the indicated property, i.e., molecular weight or melt viscosity, is expressed for the entire subject coating composition.

In a first aspect, there is provided an article comprising a substrate having a first surface and a melt coated layer having a first major surface and a second major surface, the first major surface of the melt coated layer being disposed upon the first surface of the substrate, wherein the melt coated layer is substantially continuous and comprises a melt coated composition selected from the group consisting of:

(a) one or more acrylic polymers having a collective molecular weight of at least about 200,000, and the melt coated layer has a coating weight less than about 25 g/m^2, is free of solvents, and contains no more than about 1% by weight of gelled acrylic polymer;

(b) one or more thermoplastic elastomers having a collective melt viscosity greater than about 20,000 cP, measured at any temperature suitable for hot-melt coating and at shear rates less than 100 sec^{-1} or frequencies less than 100 rad/sec , and the melt coated layer has a coating weight less than about 12 g/m^2;

(c) one or more natural rubbers or synthetic rubbers, none of which are thermoplastic elastomers, having a collective molecular weight of at least about 200,000 g/mol and a collective melt viscosity greater than about 50,000 cP, measured at any temperature suitable for hot-melt coating and at shear rates less than 100 sec^{-1} or frequencies less than 100 rad/sec, and the melt coated layer has a coating weight less than about 29 g/m^2; and

(d) one or more nonelastomeric thermoplastic polymers having a collective molecular weight of from about 50,000 to about 3,000,000 g/mol, and the melt coated layer has a coating weight less than about 17 g/m^2 and is free of solvents.

In brief summary, methods of the disclosure ~~invention~~ comprise:

(a) conveying a molten coating composition as described herein through a die slot having a thickness less than about 30 mils (760 micrometers);

(b) melt coating the composition onto a substrate, e.g., directly contacting the molten composition to the entry side of a nip point between a rotating rod having a diameter less than about 3 inches (7.6 cm) and a moving substrate supported on a backup roller wherein the pressure of the nip point preferably causes deformation of the backup roller; and

(c) obtaining a coated substrate on the exit side of the nip;

wherein the rotating rod and the backup roller are each rotating in the direction of motion of the moving substrate, i.e., forward rotation; and

wherein the rotating rod is rotating at greater than about 20 rpm, and has tangential surface speed that is from about 1 to about 20% of the tangential speed of the moving substrate. It has been surprisingly found that by this process wherein the rotating rod is located in the delivery slot of the die, the rod acts as a metering device and the coating composition is "sheared down" and "smeared" on to the substrate in a manner that permits the formation of ultrathin melt coatings.

In a second aspect, there is provided a process for making articles with a melt coated layer thereon, the process comprising the steps of:

(a) conveying a molten coating composition comprising a polymer through a die slot having a thickness less than about 35 mils;

(b) directly contacting the molten composition to the entry side of a nip point between a rotating rod having a diameter less than about 3 inches (7.6 cm) and a moving substrate supported on a backup roller, wherein a sufficiently small nipping pressure is employed such that the surface of the backup roller is deformed by no more than a depth of about 20 mils; and

(c) obtaining a substrate with a melt coated layer thereon on the exit side of the nip point;

wherein the rotating rod and the compressible backup roller are each rotating in the direction of motion of the moving substrate; and

wherein the rotating rod is rotating at greater than about 20 rpm, and has surface speed that is between about 1 and about 20% of the speed of the moving substrate

The method of the disclosure ~~invention~~ employs melt processing, i.e., application of heat and mechanical pressure on the composition and relative movement of the substrate, to extrude the coating composition into desired location and thickness on the substrate. Unlike previously known methods typically used for coating high molecular weight, high viscosity PSA and other compositions, no liquid carrier medium or solvent is used. As a result, no drying of the resultant coating is necessary, thereby eliminating potentially costly further operations, such as special drying and solvent recovery systems, as well as eliminating the risk that the substrate be exposed to potentially damaging post-coating treatments to the melt coated layer.

Applicants have found that the present disclosure ~~invention~~ can be used to make heretofore unattainably high quality coatings of PSA materials with selected high viscosity, high molecular weight materials. Another advantage of the disclosure ~~invention~~ is that the coatings can be made at heretofore unattainable combinations of high speed and very thin caliper. As a result, the disclosure ~~invention~~ enables for the first time high speed production of, for instance, articles with very thin PSA coatings. Resultant advantages include potential economies of scale in production of such articles, reduced cost of the resultant articles, and

potential improved performance as the thickness of the PSA coating can be reduced to eliminate materials cost, improve other properties, e.g., weight, flexibility, etc. of the resultant article.

Although this description describes the method and articles ~~of the invention~~ with reference to PSA coatings, it should be understood that advantages of the disclosure ~~invention~~ can be attained using other melt coatings. Illustrative examples include thin bonding layers, e.g., thermoplastic adhesive layers, thin elastomeric layers, e.g., thermoplastic elastomers (TPE), and conformable layers.

The present disclosure ~~invention~~ extends the range of melt coating thickness which can be achieved for polymeric materials, particularly for materials having high molecular weight, e.g., above 200,000 g/mol, high melt viscosity, e.g., above 50 Pa-s. It has been surprisingly found that continuous coatings of such materials having very low thickness can be achieved. Accordingly, the present disclosure ~~invention~~ provides heretofore unattainable significant potential cost savings, reduced materials consumption and enhanced sustainability. In addition, the present disclosure ~~invention~~ makes thinner, lighter products possible.

Typically, melt coatings of the disclosure ~~invention~~ are substantially continuous, i.e., free of pin hole type defects. In some embodiments, melt coatings of the disclosure ~~invention~~ have a micro-textured surface (i.e., the side opposite to the side contacting the substrate). Such melt coatings can exhibit a significantly lower coating density than coatings of the same material which have smooth surfaces, i.e., substantially uniform thickness. Coatings of the disclosure ~~invention~~ can typically exhibit a coating density that is from about 60 to about 95% of the coating density of smooth edged coatings of the same material, thus providing adhesive performance with less cost. In addition to having greater thicknesses, i.e., having greater coating weights, coatings resultant of the methods disclosed in US Pat. No. 4,167,914 would exhibit a coating density on the order of 95 to 100% of smooth edged coatings of the same material.

Brief Description of Drawing

The invention is further explained with reference to the drawing wherein:

Fig. 1 is a fragmentary side elevation of the coating head, press roll, rotating rod, and rod seat of the prior art;

Fig. 2 is a fragmentary side elevation of the coating head, press roll, rotating rod, and rod seat of the method of the invention;

Fig. 3 is a photomicrograph of the exposed surface of the melt coated layer of an article of the invention; and

Fig. 4 is a photomicrograph of the edge of an article of the invention.

These figures are not to scale and are intended to be merely illustrative and not limiting.

Key and Glossary

Unless otherwise indicated, all numbers expressing quantities of ingredients, properties such as molecular weight, reaction conditions, and so forth used in the specification and claims are to be understood as being modified in all instances by the term "about". Accordingly, unless indicated to the