Summary

~~In one aspect, t~~The disclosure describes a barrier film including a substrate, a base (co)polymer layer on a major surface of the substrate, an oxide layer on the base (co)polymer layer; and a protective (co)polymer layer on the oxide layer, the protective (co)polymer layer comprising a reaction product of:

a first (meth)acryloyl compound, and

a (meth)acryl-silane compound derived from a Michael reaction between a second (meth)acryloyl compound and an aminosilane.

In some exemplary embodiments, the first (meth)acryloyl compound is different from the second (meth)acryloyl compound. In other exemplary embodiments, the first (meth)acryloyl compound is the same as the second (meth)acryloyl compound. In one aspect, the disclosure describes a barrier film comprising a substrate; a base (co)polymer layer on a major surface of the substrate; an oxide layer on the base (co)polymer layer; and a protective (co)polymer layer on the oxide layer, the protective (co)polymer layer comprising a reaction product of: a first (meth)acryloyl compound, and a (meth)acryl-silane compound derived from a Michael reaction between a second (meth)acryloyl compound and an aminosilane, optionally wherein the first (meth)acryloyl compound is the same as the second (meth)acryloyl compound. An optional inorganic layer, which preferably is an oxide layer, can be applied over the protective (co)polymer layer.

In another aspect, the disclosure describes an article incorporating a barrier film as defined herein, wherein the article is selected from a photovoltaic device, a display device, a solid state lighting device, and combinations thereof.

In another aspect, the disclosure describes a process for making a barrier film, the process including:

(a) applying a base (co)polymer layer to a major surface of a substrate;

(b) applying an oxide layer on the base (co)polymer layer; and

(c) depositing on the oxide layer a first (meth)acryloyl compound and a (meth)acryl-silane compound derived from a Michael reaction between a second (meth)acryloyl compound and an aminosilane, and reacting the (meth)acryl-silane compound with the first (meth)acryloyl compound to form a protective (co)polymer layer on the oxide layer.

In one exemplary presently preferred embodiment, the disclosure describes a process for making a barrier film, the process including:

(a) vapor depositing and curing a base (co)(co)polymer layer onto a major surface of a substrate;

(b) vapor depositing an oxide layer on the base (co)(co)polymer layer; and

(c) vapor depositing on the oxide layer a first (meth)acryloyl compound and a (meth)acryl-silane compound derived from a Michael reaction between a second (meth)acryloyl compound and an aminosilane, and reacting the (meth)acryl-silane compound with the first (meth)acryloyl compound to form a protective (co)polymer layer on the oxide layer.

In some exemplary embodiments, the first (meth)acryloyl compound is different from the second (meth)acryloyl compound. In other exemplary embodiments, the first (meth)acryloyl compound is the same as the second (meth)acryloyl compound. An optional inorganic layer, which preferably is an oxide layer, can be applied over the protective (co)polymer layer.

~~In a further aspect, t~~The disclosure also describes methods of using a barrier film made as described above in an article selected from a photovoltaic device, a display device, a solid state lighting device, and combinations thereof.

Exemplary embodiments of the present disclosure provide barrier films which exhibit improved moisture resistance when used in moisture barrier applications. Exemplary embodiments of the disclosure can enable the formation of barrier films that exhibit superior mechanical properties such as elasticity and flexibility yet still have low oxygen or water vapor transmission rates. Exemplary embodiments of barrier films according to the present disclosure are preferably transmissive to both visible and infrared light. Exemplary embodiments of barrier films according to the present disclosure are also typically flexible. Exemplary embodiments of barrier films according to the present disclosure generally do not exhibit delamination or curl that can arise from thermal stresses or shrinkage in a multilayer structure. The properties of exemplary embodiments of barrier films disclosed herein typically are maintained even after high temperature and humidity aging.

Various aspects and advantages of exemplary embodiments of the disclosure have been summarized. The above Summary is not intended to describe each illustrated embodiment or every implementation of the present certain exemplary embodiments of the present disclosure. The Drawings and the Detailed Description that follow more particularly exemplify certain preferred embodiments using the principles disclosed herein.

Brief Description of the Drawings

The accompanying drawings are incorporated in and constitute a part of this specification and, together with the description, explain the advantages and principles of exemplary embodiments of the present disclosure.

FIG. 1 is a diagram illustrating an exemplary moisture-resistant barrier film having a vapor-deposited adhesion-promoting coating according to an exemplary embodiment of the present disclosure; and