protection from moisture and oxygen. Examples of such transparent multilayer barrier coatings and processes can be found, for example, in U.S. Patent Nos. 5,440,446 (Shaw et al.); 5,877,895 (Shaw et al.); 6,010,751 (Shaw et al.); 7,018,713 (Padiyath et al.); and 6,413,645 (Graff et al.).

SUMMARY

The present disclosure describes an article including a substrate selected from a (co)polymeric film or an electronic device, the electronic device further including an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof; 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, wherein the protective (co)polymer layer includes the reaction product of at least one urethane (multi)-(meth) acrylate (multi)-silane precursor compound of the formula R_S-N(H)-C(O)-O-R_A or R_S-O-C(O)-N(H)-R_A. R_S is a silane containing group of the formula -R^1-$[Si(Y_p)(R^2)_{3-p}]_q$, in which R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, each Y is a hydrolysable group, R^2 is a monovalent alkyl or aryl group; p is 1, 2, or 3, and q is 1-5. R_A is a (meth)acryl group containing group of the formula R^{11}-$(A)_n$, in which R^{11} is a polyvalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, A is a (meth)acryl group comprising the formula X^2-C(O)-C(R^3)=CH_2, in which X^2 is -O, -S, or –NR^3, R^3 is H, or C_1-C_4, and n=1 to 5.

In one aspect, the present disclosure relates to an article, comprising: a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof; 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, wherein the protective (co)polymer layer comprises ~~the~~ a reaction product of at least one urethane (multi)-(meth)acrylate (multi)-silane precursor compound of the formula: R_S-N(H)-C(O)-O-R_A or R_S-O-C(O)-N(H)-R_A, wherein: R_S is a silane containing group of the formula -R^1-$[Si(Y_p)(R^2)_{3-p}]_q$, further wherein: R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, each Y is a hydrolysable group, R^2 is a

transistor, a photovoltaic device, or a combination thereof; (b) applying an oxide layer on the base (co)polymer layer; and (c) depositing on the oxide layer a protective (co)polymer layer, wherein the protective (co)polymer layer comprises ~~the~~ a reaction product of at least one urethane (multi)-(meth)acrylate (multi)-silane precursor compound of the formula: R_S-N(H)-C(O)-O-R_A or R_S-O-C(O)-N(H)-R_A, wherein: R_S is a silane containing group of the formula -R^1-[Si(Y_p)(R^2)$_{3-p}$]$_q$, further wherein: R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, each Y is a hydrolysable group, R^2 is a monovalent alkyl or aryl group; p is 1, 2, or 3, and q is 1-5; and R_A is a (meth)acryl group containing group of the formula R^{11}-(A)$_n$, wherein: R^{11} is a polyvalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, A is a (meth)acryl group comprising the formula X^2-C(O)-C(R^3)=CH_2, further wherein: X^2 is -O, -S, or –NR^3, R^3 is H, or C_1-C_4, and n=1 to 5.

In some exemplary embodiments of the process, the at least one urethane (multi)-(meth)acrylate (multi)-silane precursor compound undergoes a chemical reaction to form the protective (co)polymer layer at least in part on the oxide layer. Optionally, the chemical reaction is selected from a free radical polymerization reaction, and a hydrolysis reaction. In any of the foregoing articles, each hydrolysable group Y is independently

Claims

1. An article, comprising:

a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof;

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, wherein the protective (co)polymer layer comprises ~~the~~ a reaction product of at least one urethane (multi)-(meth)acrylate (multi)-silane precursor compound of the formula:

R_S-N(H)-C(O)-O-R_A or R_S-O-C(O)-N(H)-R_A, wherein:

R_S is a silane containing group of the formula -R^1-[Si(Y_p)(R^2)$_{3-p}$]$_q$, further wherein:

R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

each Y is a hydrolysable group,

R^2 is a monovalent alkyl or aryl group;

p is 1, 2, or 3, and

q is 1-5; and

R_A is a (meth)acryl group containing group of the formula R^{11}-(A)$_n$, wherein:

R^{11} is a polyvalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

A is a (meth)acryl group comprising the formula X^2-C(O)-C(R^3)=CH_2,

further wherein:

X^2 is -O, -S, or –NR^3,

R^3 is H, or C_1-C_4, and

n=1 to 5.

2. The article of claim 1, wherein Y is individually selected from the group consisting of alkoxy groups, acetate groups, aryloxy groups, and halogens.

12. A process, comprising:

(a) applying a base (co)polymer layer to a major surface of a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof;

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

(c) depositing on the oxide layer a protective (co)polymer layer, wherein the protective (co)polymer layer comprises ~~the~~ a reaction product of at least one urethane (multi)-(meth)acrylate (multi)-silane precursor compound of the formula:

R_S-N(H)-C(O)-O-R_A or R_S-O-C(O)-N(H)-R_A, wherein:

R_S is a silane containing group of the formula -R^1-[$Si(Y_p)(R^2)_{3-p}]_q$, further wherein:

R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

each Y is a hydrolysable group,

R^2 is a monovalent alkyl or aryl group;

p is 1, 2, or 3, and

q is 1-5; and

R_A is a (meth)acryl group containing group of the formula R^{11}-$(A)_n$, wherein:

R^{11} is a polyvalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

A is a (meth)acryl group comprising the formula X^2-C(O)-$C(R^3)$=CH_2,

further wherein:

X^2 is -O, -S, or –NR^3,

R^3 is H, or C_1-C_4, and

n=1 to 5.

13. The process of claim 12, wherein Y is selected from the group consisting of alkoxy groups, acetate groups, aryloxy groups, and halogens.

14. The process of claim 13, wherein Y is selected from alkoxy groups.