What is claimed is:

1. A barrier film comprising:

a substrate;

a first polymer layer on a major surface of the substrate;

an oxide layer on the first polymer layer; and

a second polymer layer on the oxide layer,

wherein at least one of the first or second polymer layers comprises a siloxane reaction product of a secondary or tertiary amino-functional silane having at least two independently selected silane groups, wherein the secondary or tertiary amino-functional silane is other than bis-(gamma-triethoxysilylpropyl)amine.

2. The barrier film of claim 1, wherein the secondary or tertiary amino-functional silane is represented by formula

$$(R^3)_2N\text{-}R^1\text{-}[Si(Y)_p(R^2)_{3-p}]$$

wherein

R^1 is a multivalent alkylene group optionally interrupted by one or more –O- groups or up to three $–NR^3$- groups;

R^2 is alkyl, arylalkylenyl, or $-R^1\text{-}[Si(Y)_p(R^2)_{3-p}]$;

each R^3 is independently hydrogen, alkyl, arylalkylenyl, or $-R^1\text{-}[Si(Y)_p(R^2)_{3-p}]$;

Y is alkoxy, acetoxy, aryloxy, or halogen; and

p is 1, 2, or 3;

with the provisos that at least two independently selected $-Si(Y)_p(R^2)_{3-p}$ groups are present and that both R^3 groups may not be hydrogen.

3. The barrier film of claim 2, wherein one R^3 is alkyl or hydrogen, and the other R^3 is $-R^1\text{-}[Si(Y)_p(R^2)_{3-p}]$.

4. The barrier film of any one of claims 1 to 3, wherein the at least two independently selected silane groups are other than triethoxysilane groups.

45. The barrier film of any one of claims 1 to 42, wherein the secondary or tertiary amino-functional silane is bis(3-trimethoxysilylpropyl)amine, N-methyl-bis(3-trimethoxysilylpropyl)amine, or N,N'-bis[3-trimethoxysilylpropyl]-ethylenediamine.

~~5~~6. The barrier film of any one of claims 1 to ~~3~~4, wherein in the at least two independently selected silane groups, Y is methoxy, acetoxy, or chloro, and p is 3.

7. The barrier film of any one of claims 1 to 6, wherein the siloxane reaction product shares a siloxane bond with the oxide layer.

~~6~~8. The barrier film of any one of claims 1 to ~~5~~7, wherein at least the second polymer layer comprises the siloxane reaction product.

~~7~~9. The barrier film of any one of claims 1 to ~~6~~8, wherein the barrier film comprises a plurality of alternating oxide layers and second polymer layers on the first polymer layer.

~~8~~10. The barrier film of any one of claims 1 to ~~7~~9, wherein the substrate comprises at least one of polyethylene terephthalate, polyethylene naphthalate, polyetheretherketone, polyaryletherketone, polyacrylate, polyetherimide, polyarylsulfone, polyethersulfone, polyamideimide, polyimide, ethylene-tetrafluoroethylene copolymer, tetrafluoroethylene-hexafluoropropylene copolymer, tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymer, or polyvinylidene fluoride, any of which may optionally be heat-stabilized.

~~9~~11. The barrier film of any one of claims 1 to ~~8~~10, wherein at least one of the first or second polymer layers comprises a polymerized acrylate or methacrylate.

~~10~~12. The barrier film of claim ~~9~~11, wherein the acrylate or methacrylate is tricyclodecanedimethanol diacrylate, 3-(acryloxy)-2-hydroxy-propylmethacrylate, triacryloxyethyl isocyanurate, glycerol diacrylate, ethoxylated trimethylolpropane diacrylate, pentaerythritol triacrylate, pentaerythritol tetraacrylate, propoxylated (3) glyceryl diacrylate, propoxylated (5,5) glyceryl diacrylate, propoxylated (3) trimethylolpropane diacrylate, propoxylated (6) trimethylolpropane diacrylate, trimethylolpropane diacrylate, trimethylolpropane triacrylate, di-trimethylolpropane tetraacrylate, dipentaerythritol pentaacrylate, or combinations thereof.

13. The barrier film of claim 11 or 12, wherein the siloxane reaction product includes an amide bond derived from reaction between the amino group and the acrylate or methacrylate.

14. A barrier assembly comprising the barrier film of any one of claims 1 to 13, wherein a major surface of the barrier film is adhered to a top sheet with a pressure sensitive adhesive.

~~11~~15. ~~A~~ The barrier assembly ~~comprising the barrier film of any one of claims 1 to 10~~of claim 14, ~~wherein a major surface of the barrier film is adhered to a top sheet with a pressure sensitive adhesive.~~ wherein the top sheet comprises at least one of an ethylene-tetrafluoroethylene copolymer, a tetrafluoroethylene-hexafluoropropylene copolymer, a tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymer, or polyvinylidene fluoride.

~~12~~16. The barrier assembly of claim ~~11~~14 or 15, wherein a major surface of the barrier film opposite the major surface of the barrier film adhered to the top sheet is disposed on a photovoltaic cell.

17. The barrier assembly of claim 16, wherein the photovoltaic cell is a CIGS cell.

18. The barrier assembly of claim 16 or 17, wherein the major surface of the barrier film opposite the major surface of the barrier film adhered to the top sheet is attached to the photovoltaic cell with an encapsulant.

~~13~~19. An article incorporating a barrier film according to any one of claims 1 to ~~10~~13, wherein the article is a solid state lighting device, a display device, or a combination thereof.

20. The article of claim 19, wherein the solid state lighting device is a semiconductor light-emitting diode, an organic light-emitting diode, or a polymer light-emitting diode.

21. The article of claim 19, wherein the display device is a liquid crystal display, an organic light-emitting diode display, or a quantum dot display.

~~14~~22. A method of making a barrier film of any one of claims 1 to ~~5~~7 and ~~8~~10, the method comprising:
providing a first polymer layer to a surface of a substrate;
providing an oxide layer on the first polymer layer; and
providing a second polymer layer on the oxide layer,

wherein at least one of the first or second polymer layers comprises a siloxane reaction product of a secondary or tertiary amino-functional silane having at least two silane groups, wherein the secondary or tertiary amino-functional silane is other than bis-(gamma-triethoxysilylpropyl)amine.

~~15~~23. The method of claim ~~14~~22, wherein providing a second polymer layer comprises evaporating the secondary or tertiary amino-functional silane, evaporating a second polymer precursor, depositing the evaporated second polymer precursor and the evaporated secondary or tertiary amino-functional silane on the oxide layer, and curing the deposited second polymer precursor to form the second polymer layer.

24. The method of claim 23, wherein evaporating a second polymer precursor and evaporating the secondary or tertiary amino-functional silane together comprise evaporating a mixture of the second polymer layer precursor and the secondary or tertiary amino-functional silane.

25. The method of claim 23 or 24, wherein the second polymer precursor comprises at least one of an acrylate or a methacrylate monomer.

26. The method of claim 25, wherein the acrylate or methacrylate is tricyclodecanedimethanol diacrylate, 3-(acryloxy)-2-hydroxy-propylmethacrylate, triacryloxyethyl isocyanurate, glycerol diacrylate, ethoxylated trimethylolpropane diacrylate, pentaerythritol triacrylate, propoxylated (3) glyceryl diacrylate, propoxylated (5.5) glyceryl diacrylate, propoxylated (3) trimethylolpropane diacrylate, propoxylated (6) trimethylolpropane diacrylate, trimethylolpropane diacrylate, trimethylolpropane triacrylate, di-trimethylolpropane tetraacrylate, dipentaerythritol pentaacrylate, or combinations thereof.

27. The method of any one of claims 22 to 26, wherein providing the oxide layer comprises depositing an oxide onto the first polymer layer to form the oxide layer, wherein depositing is achieved using sputter deposition, reactive sputtering, chemical vapor deposition, or a combination thereof.

28. The method of any one of claims 22 to 27, wherein providing the oxide layer comprises applying a layer of an inorganic silicon aluminum oxide to the first polymer layer.

29. The method of any one of claims 22 to 28, further comprising sequentially repeating providing the oxide layer on the first polymer layer and providing the second polymer layer on the oxide layer to form a plurality of alternating layers of the second polymer layer and the oxide layer on the first polymer layer.