temperature covalent bonding between the thin sheet and carrier. Even more specifically, the present disclosure describes methods of depositing a coating layer that serves to bond a thin sheet to a carrier, methods for preparing the coating layer for bonding, and bonding the coating layer to both the thin sheet and the carrier. These methods produce bonding between the components such that the bonding energy is not too high, which might render the components inseparable after electronic device processing, and such that the bonding energy is not too low, which might lead to compromised bonding quality thus leading to possible de-bonding or fluid ingress between the thin sheet and carrier during electronic device processing. These methods also produce a glass article that exhibits low outgassing and survives high temperature processing for example, LTPS TFT processing as well additional processing steps, for example wet cleaning and dry etching. In alternative embodiments, the coating layers may be used to create various controlled bonding areas (wherein the carrier and thin sheet remain sufficiently bonded through various processes, including vacuum processing, wet processing, and/or ultrasonic cleaning processing), together with covalent bonding regions to provide for further processing options, for example, maintaining hermeticity between the carrier and sheet even after dicing the article into smaller pieces for additional device processing.

[0009] There is an article comprising:

a first sheet comprising a first sheet bonding surface;

a second sheet comprising a second sheet bonding surface; and

a coating layer comprising a first coating layer bonding surface and a second coating layer bonding surface, the coating layer comprising a plasma-polymerized organosiloxane compound;

the first coating layer bonding surface being bonded with the first sheet bonding surface, and the second coating layer bonding surface being bonded with the second sheet bonding surface.

[0009a] In a first aspect, there is an article comprising:

a first sheet comprising a first sheet bonding surface;

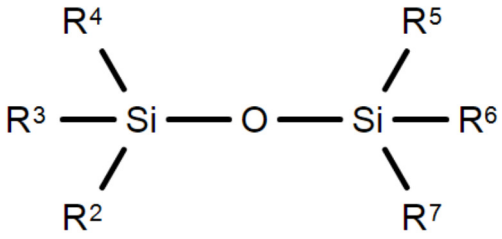
a second sheet comprising a second sheet bonding surface; and

a coating layer comprising a first coating layer bonding surface and a second coating layer bonding surface, the coating layer comprising a plasma-polymerized organosiloxane compound formed by depositing a monomer on at least one of the first sheet bonding surface and the second sheet bonding surface;

the first coating layer bonding surface is bonded with the first sheet bonding surface, and the second coating layer bonding surface is bonded with the second sheet bonding surface,

wherein the monomer comprises a compound of formula $(R^1)_mSi(X^1)_n$, wherein each R^1 is independently an aryl; m is 1, 2 or 3; each X^1 is independently an alkoxy; and n is 1, 2 or 3; or

wherein the monomer comprises a disiloxane compound having the structure below, wherein each of R^2-R^7 is independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof



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[0010] In an example, the coating layer comprises poly(diphenylsiloxane).

[0011] In another example, the first coating layer bonding surface has a surface energy between 40 and 75 mJ/m^2.

[0012] In another example, the coating layer has a thickness of less than 100 nm.

[0013] In another example, the coating layer is a single layer.

[0014] In another example, the first sheet has a thickness less than 200 μm.

[0024] In an example, the monomer is deposited on at least one of the first sheet bonding surface and the second sheet bonding surface using low-pressure plasma chemical vapor deposition (CVD) or atmospheric pressure plasma CVD.

[0025] There is provided an article as defined herein, the monomer comprising a compound of formula $(R^1)_mSi(X^1)_n$, wherein each R^1 is independently aryl, alkyl, alkenyl alkynyl, or a combination thereof; m is 1, 2 or 3; each X^1 is independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof; and n is 1, 2 or 3.

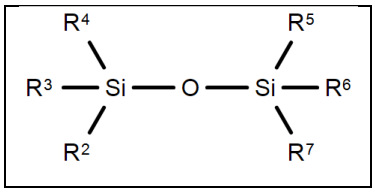
[0026] In an example, R^1 is aryl.

[0027] In another example, X^1 is alkoxy.

[0028] In another example, R^1 is aryl and X^1 is alkoxy.

[0029] In another example, the monomer is phenyltrimethoxysilane, phenyltriethoxysilane, phenyltribromosilane, phenyltrichlorosilane, dimethoxydiphenylsilane, diethoxydiphenylsilane, dibromodiphenylsilane, dichlorodiphenylsilane, bis(dimethylamino)diphenylsilane, bis(diethylamino)diphenylsilane, phenylsilane, or diphenylsilane.

[0030] There is provided an article as defined herein, the monomer comprising a disiloxane compound having the structure below, wherein each of R^2-R^7 is independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof.



[0031] In an example, the monomer is hexamethyldisiloxane.

[0032] There is provided an article as defined herein, the coating layer is comprised of a bottom coating layer and a top coating layer, the bottom coating layer being between the top coating layer and the second sheet.

[0033] In an example, the bottom coating layer has a thickness between 10 and 80 nm and the top coating layer has a thickness between 10 and 50 nm.

[0034] There is a method of making an article comprising:

forming a coating layer comprising a plasma-polymerized organosiloxane compound on a bonding surface of a second sheet by depositing a monomer on the bonding surface of

the second sheet using plasma CVD, the coating layer comprising a coating layer bonding surface; and

bonding the coating layer bonding surface to a bonding surface of a first sheet.

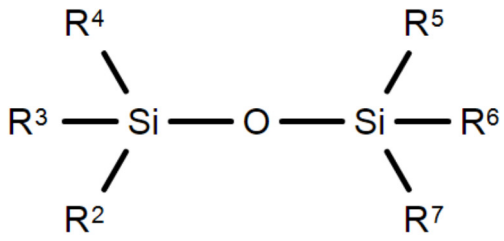
[0034a] In a second aspect, there is a method of making an article comprising:

forming a coating layer comprising a plasma-polymerized organosiloxane compound on a bonding surface of a second sheet by depositing a monomer on the bonding surface of the second sheet using plasma CVD, the coating layer comprising a coating layer bonding surface; and

bonding the coating layer bonding surface to a bonding surface of a first sheet,

wherein the monomer comprises a compound of formula $(R^1)_mSi(X^1)_n$, wherein each R^1 is independently an aryl; m is 1, 2 or 3; each X^1 is independently an alkoxy; and n is 1, 2 or 3; or

wherein the monomer comprises a disiloxane compound having the structure below, wherein each of R^2-R^7 is independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof



[0035] In an example, the monomer is deposited on the bonding surface of the second sheet using low pressure plasma CVD or atmospheric pressure plasma CVD.

[0036] In an example, the coating layer comprises poly(diphenylsiloxane).

[0037] In another example, the coating layer has a thickness less than 100 nm.

[0038] In another example, the coating layer is a single layer.

[0039] In another example, the first sheet has a thickness less than 200 μm.

[0040] In another example, the coating layer bonding surface is bonded with the first sheet bonding surface with a bond energy of less than 600 mJ/m^2 after subjecting the article to a temperature of 600 °C for 10 minutes in a nitrogen atmosphere.

[0041] In another example, the first sheet is a glass sheet.

[0042] In another example, the second sheet is a glass sheet.

[0043] In another example, the first sheet is a glass sheet and the second sheet is a glass sheet.

[0044] There is provided the method as defined herein, further comprising increasing the surface energy of the coating layer bonding surface before the bonding surface of the first sheet is bonded to the coating layer bonding surface.

[0045] In an example, the surface energy of the coating layer bonding surface is increased by exposing the bonding surface to oxygen, nitrogen, or a combination thereof.

[0046] In another example, the surface energy of the coating layer bonding surface is increased to between 40 and 75 mJ/m^2.

[0047] There is provided the method as defined herein, the monomer comprising a compound of formula $(R^1)_mSi(X^1)_n$, wherein each R^1 is independently aryl, alkyl, alkenyl, alkynyl, or a combination thereof; m is 1, 2 or 3; each X^1 is independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof; and n is 1, 2 or 3.

[0048] In an example, R^1 is aryl.

[0049] In another example, X^1 is alkoxy.

[0050] In another example, R^1 is aryl and X^1 is alkoxy.

[0051] In another example, the monomer is phenyltrimethoxysilane, phenyltriethoxysilane, phenyltribromosilane, phenyltrichlorosilane, dimethoxydiphenylsilane, diethoxydiphenylsilane, dibromodiphenylsilane, dichlorodiphenylsilane,

What is claimed is:

1. An article comprising:

a first sheet comprising a first sheet bonding surface;

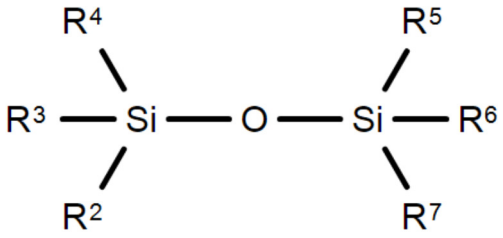
a second sheet comprising a second sheet bonding surface; and

a coating layer comprising a first coating layer bonding surface and a second coating layer bonding surface, the coating layer comprising a plasma-polymerized organosiloxane compound formed by depositing a monomer on at least one of the first sheet bonding surface and the second sheet bonding surface;

the first coating layer bonding surface is bonded with the first sheet bonding surface, and the second coating layer bonding surface is bonded with the second sheet bonding surface,

wherein the monomer comprises a compound of formula $(R^1)_mSi(X^1)_n$, wherein each R^1 is independently an aryl; m is 1, 2 or 3; each X^1 is independently an alkoxy; and n is 1, 2 or 3; or

wherein the monomer comprises a disiloxane compound having the structure below, wherein each of R^2-R^7 is independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof



2. The article of claim 1, the coating layer comprising poly(diphenylsiloxane).

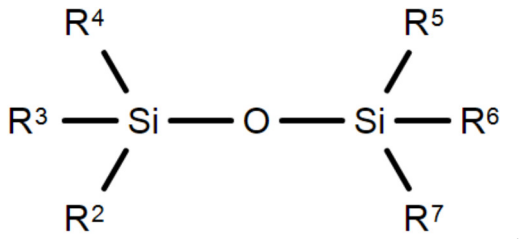
3. A method of making an article comprising:

forming a coating layer comprising a plasma-polymerized organosiloxane compound on a bonding surface of a second sheet by depositing a monomer on the bonding surface of the second sheet using plasma CVD, the coating layer comprising a coating layer bonding surface; and

bonding the coating layer bonding surface to a bonding surface of a first sheet,

wherein the monomer comprises a compound of formula $(R^1)_mSi(X^1)_n$, wherein each R^1 is independently an aryl; m is 1, 2 or 3; each X^1 is independently an alkoxy; and n is 1, 2 or 3; or

wherein the monomer comprises a disiloxane compound having the structure below, wherein each of R^2-R^7 is independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof



4. The method of claim 3, further comprising exposing the bonding surface to oxygen, nitrogen, or a combination thereof , to increase the surface energy of the coating layer bonding surface before the bonding surface of the first sheet is bonded to the coating layer bonding surface, the surface energy of the coating layer bonding surface being increased to between 40 and 75 mJ/m^2.

5. The method of claim 3, wherein the monomer comprises at least one monomer selected from the group consisting of phenyltrimethoxysilane, phenyltriethoxysilane, phenyltribromosilane, phenyltrichlorosilane, dimethoxydiphenylsilane, diethoxydiphenylsilane, dibromodiphenylsilane, dichlorodiphenylsilane, bis(dimethylamino)diphenylsilane, bis(diethylamino)diphenylsilane, phenylsilane, and diphenylsilane.

6. The method of claim 3 or 4, wherein the monomer is hexamethyldisiloxane.

7. The method of any one of claims 3-6, the coating layer comprising poly(diphenylsiloxane).

8. The method of any one of claims 3-7, further comprising subjecting the coating layer to thermal annealing, at a temperature of at least 300 °C in a nitrogen atmosphere, before the first sheet and the coating layer are bonded.

9. An article comprising:

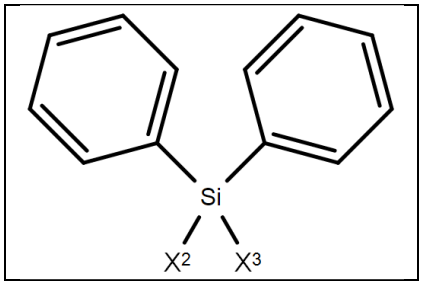
a first sheet comprising a first sheet bonding surface;

a second sheet comprising a second sheet bonding surface; and

a coating layer comprising a first coating layer bonding surface and a second coating layer bonding surface, the coating layer comprising poly(diphenylsiloxane);

the first coating layer bonding surface is bonded with the first sheet bonding surface, and the second coating layer bonding surface is bonded with the second sheet bonding surface.

10. The article of claim 9, the poly(diphenylsiloxane) coating layer formed by depositing a monomer on at least one of the first sheet bonding surface and the second sheet bonding surface, wherein the monomer is deposited on at least one of the first sheet bonding surface and the second sheet bonding surface, the monomer comprising a diphenylsilane compound having the structure below, wherein X^2 and X^3 are independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof.

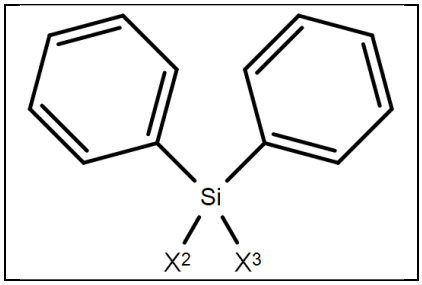


11. A method of making an article comprising:

forming a coating layer comprising poly(diphenylsiloxane) on a bonding surface of a second sheet by depositing a monomer on the bonding surface of the second sheet, the coating layer comprising a coating layer bonding surface; and

bonding the coating layer bonding surface to a bonding surface of a first sheet.

12. The method of claim 11, the monomer comprising a diphenylsilane compound having the structure below, wherein X^2 and X^3 are independently hydrogen, halogen, hydroxy, alkoxy, amino, aryl, alkyl, alkenyl, alkynyl, or a combination thereof.



13. The method of claim 11 or claim 112 further comprising subjecting the coating layer to thermal annealing, at a temperature of at least 300 °C in a nitrogen atmosphere, before the first sheet and the coating layer are bonded.