from the carrier, even after high-temperature processing. Such controlled bonding can be utilized to create an article having a re-usable carrier, or alternately an article having patterned areas of controlled bonding between a carrier and a sheet. More specifically, the present disclosure provides coating layers (including various materials and associated surface treatments), that may be provided on the thin sheet, the carrier, or both, to control both room-temperature van der Waals, and/or hydrogen, bonding and high temperature covalent bonding between the thin sheet and carrier. Even more specifically, the present disclosure describes methods of depositing a coating layer that can 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 debonding 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 as additional processing steps, for example wet cleaning and dry etching. In alternative examples, 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.

[009] There is an article comprising:

a first sheet comprising a first 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 polymerized hydrogenated amorphous hydrocarbon compound, the coating layer has a refractive index above about 1.8.

[0010] In some examples, the coating layer has a refractive index less than about 2.5.

[0011] In another example, the coating layer has a refractive index between about 1.9 and about 2.4.

[0012] There is an article comprising:

a first sheet comprising a first 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 polymerized hydrogenated amorphous hydrocarbon compound, the coating layer has an optical band gap of less than 2 eV.

[0013] In some examples, the coating layer has an optical band gap ranging from about 0.8 to about 2 eV.

[0014] In another example, the coating layer has an optical band gap ranging from about 1.2 to about 1.8 eV.

[0015] There is an article comprising:

a first sheet comprising a first 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 polymerized hydrogenated amorphous hydrocarbon compound, the coating layer has a Raman spectrum with an intensity ratio (D/G ratio) of a peak (D band) appearing in the range of 1350 to 1400 cm^{-1} to a peak (G band) appearing in the range of 1530 to 1600 cm^{-1} of about 0.5 to about 0.6.

[0015a] In a first aspect, there is an article comprising: a first sheet comprising

a first 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 polymerized hydrogenated amorphous hydrocarbon compound, the coating layer comprising at least one of the following:

a refractive index above about 1.8;

an optical band gap of less than 2 eV; and

an intensity ratio (D/G ratio) of a peak (D band) appearing in a range of 1350 to 1400 cm-1 to a peak (G band) appearing in a range of 1530 to 1600 cm-1 of a Raman spectrum of the coating layer is in a range of about 0.5 to about 0.6.

[0016] In some examples, the intensity ratio (D/G ratio) may be in the range of about 0.52 to about 0.58.

[0017] In another example, the peak (D band) may be at about 1380 cm^{-1} and the peak (G band) may be at about 1530 cm^{-1} of Raman spectrum.

[0018] There is an article comprising:

a first sheet comprising a first sheet bonding surface;

a coating layer comprising a first coating layer bonding surface and a second coating layer bonding surface, the coating layer comprising a polymerized hydrogenated amorphous hydrocarbon compound, the coating layer being formed by depositing a precursor compound having a hydrogen and carbon content of greater than 90 weight percent; and

the first coating layer bonding surface being bonded with the first sheet bonding surface with a bond energy of less than 700 mJ/m^2 after holding the article in a furnace at a temperature of 600 °C for 10 minutes in a nitrogen atmosphere.

[0018a] In a second aspect, there is a method of making an article comprising:

forming a coating layer, onto a first sheet bonding surface of a first sheet, by vapor depositing a precursor compound having a hydrogen and carbon content of greater than 90 weight percent; and

the coating layer comprising a polymerized hydrogenated amorphous hydrocarbon compound and a first coating layer bonding surface and a second coating layer bonding surface.

[0019] There is provided an article as defined herein, the coating layer is formed by depositing a hydrocarbon compound, the hydrocarbon compound having a formula of C_nH_y, wherein n is 1 to 6 and y is 2 to 14.

[0020] In some examples, the first coating layer bonding surface having an as-deposited surface energy greater than about 50 mJ/m^2.

[0021] In another example, the as-deposited surface energy of the first coating layer bonding surface being less than about 60 mJ/m^2.

[0022] In another example, the as-deposited surface energy of the first coating layer bonding surface being between about 50 mJ/m^2 and about 58 mJ/m^2.

[0023] In another example, the hydrocarbon compound is an alkane, the alkane being selected from the group consisting of methane, ethane, propane, butane, pentane and hexane.

[0024] In another example, the hydrocarbon compound is an alkene, the alkene being selected from the group consisting of ethylene, propylene, butylene, pentene and hexene.

[0025] In another example, the hydrocarbon compound is an alkyne, the alkyne being selected from the group consisting of ethyne, propyne, butyne, pentyne and hexyne.

[0026] There is provided an article as defined herein, further comprising a second sheet comprising a second sheet bonding surface.

[0027] In some examples, the second coating layer bonding surface being bonded with the second sheet bonding surface.

[0028] In another example, the first sheet being a glass sheet.

[0029] In another example, the second sheet being a glass sheet.

[0030] In another example, the first sheet being a glass sheet and the second sheet being a glass sheet.

[0031] There is provided an article of any of the examples as defined herein, the polymerized hydrocarbon compound being formed by depositing the hydrocarbon compound on either the first sheet bonding surface or the second sheet bonding surface using low-pressure plasma chemical vapor deposition or atmospheric pressure plasma chemical vapor deposition.

[0032] There is provided an article as defined herein, the coating layer having an average thickness of less than 10 nm.

[0033] There is provided an article as defined herein, the coating layer having an average thickness of less than 5 nm.

[0034] There is provided an article as defined herein, the coating layer being a single layer.

[0035] There is provided an article as defined herein, the first sheet having an average thickness greater than or equal to 200 μm.

[0036] There is provided an article as defined herein, the first coating layer bonding surface being bonded with the first sheet bonding surface with a bond energy

of less than 600 mJ/m^2 after holding the article in a furnace at a temperature of 600 °C for 10 minutes in a nitrogen atmosphere.

[0037] There is provided an article as defined herein, the first coating layer bonding surface being bonded with the first sheet bonding surface with a bond energy of less than 500 mJ/m^2 after holding the article in a furnace at a temperature of 500 °C for 10 minutes in a nitrogen atmosphere.

[0038] There is provided an article as defined herein, the change in percent bubble area of the coating layer being less than 10 percent according to Outgassing Test #1 after holding the article in a furnace at a temperature of 600 °C for 10 minutes in a nitrogen atmosphere.

[0039] There is provided an article as defined herein, the change in percent bubble area of the coating layer being less than 10 percent according to Outgassing Test #1 after holding the article in a furnace at a temperature of 500 °C for 10 minutes in a nitrogen atmosphere.

[0040] There is provided an article as defined herein, the change in percent bubble area of the coating layer being less than 5 percent according to Outgassing Test #1 after holding the article in a furnace at a temperature of 500 °C for 10 minutes in a nitrogen atmosphere.

[0041] There is provided an article as defined herein, the first coating layer bonding surface being exposed to a nitrogen and oxygen atmosphere to increase the surface energy of the first coating layer bonding surface prior to holding the article in a furnace at a temperature of 500° C or greater for 10 minutes in a nitrogen atmosphere.

[0042] There is a method of making an article comprising:

forming a coating layer comprising a polymerized hydrocarbon compound on a bonding surface of a first sheet by depositing a hydrocarbon compound on the bonding surface of the first sheet using plasma chemical vapor deposition, the coating layer comprising a first coating layer bonding surface bonded to the bonding surface of the first sheet and a second coating layer bonding surface, and the hydrocarbon compound having a formula of C_nH_y, wherein n is 1 to 6 and y is 2 to 14; and

bonding the second coating layer bonding surface with a second sheet bonding surface of a second sheet, the second coating layer bonding surface being bonded with the second sheet bonding surface with a bond energy of less than 700 mJ/m^2 after holding the article in a furnace at a temperature of 600 °C for 10 minutes in a nitrogen atmosphere.

[0043] In some examples, the hydrocarbon compound is an alkane, the alkane being selected from the group consisting of methane, ethane, propane, butane, pentane and hexane.

[0044] In another example, the hydrocarbon compound is an alkene, the alkene being selected from the group consisting of ethylene, propylene, butylene, pentene and hexene.

[0045] In another example, the hydrocarbon compound is an alkyne, the alkyne being selected from the group consisting of ethyne, propyne, butyne, pentyne and hexyne.

[0046] In another example, the polymerized hydrocarbon compound being a hydrogenated amorphous compound.

[0047] In another example, the first sheet being a glass sheet.

[0048] In another example, the second sheet being a glass sheet.

[0049] In another example, the first sheet being a glass sheet and the second sheet being a glass sheet.

[0050] There is provided an article as defined herein, further comprising increasing the surface energy of the second coating layer bonding surface before the second sheet bonding surface is bonded to the second coating layer bonding surface, wherein the surface energy is increased by exposing the second coating layer bonding surface to oxygen, nitrogen, or a combination thereof.

[0051] In another example, the coating layer having an average thickness of less than 10 nm.

[0052] In another example, the coating layer having an average thickness of less than 5 nm.

[0053] In another example, the second sheet having an average thickness less than or equal to 300 μm.

[0054] In another example, the plasma chemical vapor deposition being low-pressure plasma chemical vapor deposition or atmospheric pressure plasma chemical vapor deposition.

[0055] There is provided an article as defined herein, the second coating layer bonding surface being bonded with the second sheet bonding surface with a bond energy of less than 600 mJ/m^2 after holding the article in a furnace at a temperature of 500 °C for 10 minutes in a nitrogen atmosphere.

[0056] There is provided an article as defined herein, the change in percent bubble area of the second coating layer being less than 10 percent according to Outgassing

Test #1 after holding the article in a furnace at a temperature of 600 °C for 10 minutes in a nitrogen atmosphere.

[0057] There is provided an article as defined herein, the change in percent bubble area of the second coating layer being less than 10 percent according to Outgassing Test #1 after holding the article in a furnace at a temperature of 500 °C for 10 minutes in a nitrogen atmosphere.

[0058] There is provided an article as defined herein, the change in percent bubble area of the second coating layer being less than 5 percent according to Outgassing Test #1 after holding the article in a furnace at a temperature of 500 °C for 10 minutes in a nitrogen atmosphere.

[0059] There is provided an article as defined herein, the second coating layer bonding surface having an as-deposited surface energy greater than about 50 mJ/m^2.

[0060] There is provided an article as defined herein, the coating layer having a refractive index above about 1.8 or 2.

[0061] There is provided an article as defined herein, the coating layer having an optical band gap less than about 2 eV.

[0062] There is provided an article as defined herein, the coating layer having an intensity ratio (D/G ratio) of a peak (D band) appearing in the range of 1350 to 1400 cm^{-1} to a peak (G band) appearing in the range of 1530 to 1600 cm^{-1} of Raman spectrum in the range of about 0.5 to about 0.6.

[0063] Any one of the above aspects (or examples of those aspects) may be provided alone or in combination with any one or more of the examples of that aspect discussed above; e.g., the first aspect may be provided alone or in combination with any one or more of the examples of the first aspect discussed above; and the second aspect may be provided alone or in combination with any one or more of the examples of the second aspect discussed above; and so-forth.

[0064] The accompanying drawings are included to provide a further understanding of principles of the disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate some examples(s), and together with the description serve to explain, by way of example, principles and operation thereof. It is to be understood that various features disclosed in this specification and in the drawings can be used in any and all combinations. By way of non-limiting example the various features may be combined with one another as set forth in the specification, above, as aspects.

BRIEF DESCRIPTION OF THE DRAWINGS