[0007] In embodiments, the disclosure provides a laminate article comprising a glass device substrate work piece reversibly bonded to a reusable carrier, the laminate having a silicon and oxygen depleted and fluorine and carbon enriched glass surface at the interface.

[0008] In embodiments, the disclosure provides a method for bonding and debonding a laminate comprising a glass device substrate work piece and a carrier substrate for the work piece.

[0009] In embodiments, the disclosure provides a method for forming a moderate or intermediate strength bond or adhesion between a carrier and a thin glass device substrate to create a temporary bond, which temporary bond is sufficiently strong to survive, for example, thin film transistors (TFT) processing, but the bond is sufficiently weak to permit timely debonding or separation of the carrier substrate and the glass device substrate after surface processing of the device substrate is completed. The intermediate strength bond or moderate bonding property enables a re-usable carrier function and manufacturing cycle. The moderate bonding property can be, for example, in one or more portions of the area between the carrier substrate and the device substrate work piece, or the entire area between the carrier substrate and the device substrate work piece.

[0009a] In an aspect, there is provided a method of making a device substrate article having a device modified substrate supported on a glass carrier substrate, comprising:

treating at least a portion of the first surface of a device substrate, at least a portion of the first surface of a glass carrier substrate, or both, wherein the treated surface has:

silicon of about 0.1 to about 14 at%;

oxygen of about 1 to about 40 at%;

carbon of about 3 to 60 at%;

fluorine of about 5 to 65 at%; and

a metal to fluorine (M:F) atomic ratio of about 1:1 to about 1: 3;

contacting the treated surface with an untreated or a like-treated counterpart device substrate or glass carrier substrate to form a laminate comprised of the device substrate bonded to the glass carrier substrate; and

modifying at least a portion of the non-bonded second surface of the device substrate of the laminate with at least one device surface modification treatment to form the device substrate article.

[0009b] In an another aspect, there is provided a laminate glass article, comprising:

a glass device substrate bonded to a glass carrier substrate with at least one interfacial bonded surface that has been treated with a plasma selected from:

a fluoropolymer;

the reaction products of a fluorinated etching agent;

or a combination thereof,

wherein the interfacial bond strength between the glass device substrate and the carrier glass substrate is from about 100 to about 1,000 mJ/m^2, the interface between the glass device substrate and the glass carrier has a silicon content of from about 0.1 to about 14 at%; a fluorine content of from about 5 to 65 at%, and a metal to fluorine (M:F) atomic ratio of about 1:1 to 1: 3.

Brief Description of the Drawings

[0010] In embodiments of the disclosure:

[0011] Fig. 1 shows a schematic of the disclosed reusable carrier process (100).

[0012] Figs. 2A and 2B show the change in contact angle (Fig. 2A) and surface energy (Fig. 2B) for CF_4 and CHF_3 plasma polymer treated glass surfaces.

[0013] Figs. 3A and 3B show surface concentrations of fluorine (310) and carbon (320) and oxygen (330), (Fig. 3A) as measured by XPS and the concentration of inorganic fluorine atoms (bonded to metal) (340) and the concentration of organic fluorine atoms (in fluoropolymer) (350) (Fig. 3B) as measured by XPS for fluorocarbon plasma treated glass surfaces treated with different mol fractions of CF_4 and CHF_3.

[0014] Fig. 4 shows changes in the glass surface elemental composition in atomic % as measured by XPS with increasing polymer forming plasma treatment times for separate CHF_3 or CF_4 plasma treatments.

[0015] Figs. 5A to 5B show the change in adhesion or bond energy as a function of the anneal temperature (Fig. 5A) and anneal time (Fig. 5B) for selected surface treatments.