delamination during high temperature processing. In alternative embodiments, the surface modification layers may be used to create various controlled bonding areas (wherein the carrier and 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. Still further, some surface modification layers provide control of the bonding between the carrier and sheet while, at the same time, reduce outgassing emissions during the harsh conditions in an FPD (for example LTPS) processing environment, including high temperature and/or vacuum processing, for example. Still further yet, in alternative embodiments, some surface modification layers may be used on a carrier having a glass bonding surface to controllably bond a thin sheet having a polymer bonding surface. The polymer bonding surface may be part of a polymer thin sheet on which electronic or other structures are formed or, alternatively, the polymer bonding surface may be part of a composite sheet comprising a glass layer on which the electronic or other structures are formed.

[0013a] In a first aspect, there is provided a method for controllably bonding a substrate to a carrier, comprising: obtaining a substrate having a polymer bonding surface, the polymer bonding surface having a first surface energy; obtaining a carrier having a glass bonding surface, the glass bonding surface having a second surface energy; depositing a surface modification layer onto the glass bonding surface so as to decrease the surface energy of the glass bonding surface; and bonding the polymer bonding surface to the glass bonding surface via the surface modification layer, wherein the substrate is non-destructively debondable from the carrier after being subjected to a one hour vacuum anneal in an environment having a temperature of 120°C.

[0013b] In a second aspect, there is provided an article comprising a substrate having a polymer bonding surface; a carrier having a glass bonding surface; a plasma-polymerized surface modification layer releasably bonding the polymer bonding surface to the glass bonding surface.

[0014] Additional features and advantages will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from the description or recognized by practicing the various aspects as exemplified in the written description and the appended drawings. It is to be understood that both the foregoing general

description and the following detailed description are merely exemplary of the various aspects, and are intended to provide an overview or framework to understanding the nature and character of the invention as it is claimed.

[0015] The accompanying drawings are included to provide a further understanding of principles of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate one or more embodiment(s), and together with the description serve to explain, by way of example, principles and operation of the invention. 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 appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a schematic side view of an article having carrier bonded to a thin sheet with a surface modification layer therebetween.