thickness of 1000 μm. Substrate choice will depend on how closely matched the coefficient of thermal expansion (CTE) is between each material.

One method that has been used to mount an active wafer to a carrier substrate comprises the use of a cured bonding composition. The major drawback with this approach is that the composition must be chemically removed, typically by dissolving in a solvent. This is very time-consuming, thus reducing throughput. Furthermore, the use of the solvent adds to the cost and complexity of the process, and it can be hazardous, depending upon the solvent required to dissolve the bonding composition.

Another method for mounting an active wafer to a carrier substrate is via a thermal release adhesive tape. This process has two major shortcomings. First, the tapes have limited thickness uniformity across the active wafer/carrier substrate interface, and this limited uniformity is often inadequate for ultra-thin wafer handling. Second, the thermal release adhesive softens at such low temperatures that the bonded wafer/carrier substrate stack cannot withstand many typical wafer processing steps that are carried out at higher temperatures.

There is a need for new compositions and methods of adhering an active wafer to a carrier substrate that can endure high processing temperatures and that allow for ready separation of the wafer and substrate at the appropriate stage of the process.

SUMMARY OF THE INVENTION

~~In one embodiment, the present invention is a wafer bonding method wherein a stack comprising first and second substrates bonded together via a bonding layer is preferably subjected to various processing steps (e.g., wafer thinning). The processed stack is then heated to a temperature of at least about 190°C, and a sliding force is applied to at least one of the substrates while causing the other of the substrates to resist the force, such as by securing the other substrate or subjecting it to an opposing force. The force is applied in a sufficient amount so as to separate the substrates.~~

~~In another embodiment, the invention provides an article comprising: a first substrate having a back surface and an active surface; a second substrate having a bonding surface; and bonding layer bonded to the active and bonding surfaces.~~

According to a first aspect, there is provided a wafer bonding method comprising: providing a stack comprising first and second substrates bonded together via a bonding layer formed from a bonding composition comprising: a tackifier; and a compound selected from the group consisting of rubbers, styrene-isoprene-styrene, styrene-butadiene-styrene, halogenated butyl rubber, and mixtures thereof, said tackifier and said compound being dissolved or dispersed in a solvent system, said bonding composition comprising at least 30% by weight solvent system, based upon the total weight of the composition taken as 100% by weight; subjecting said stack to a temperature of at least 190°C so as to soften said bonding layer; and applying a force to at least one of said first and second substrates while causing the other of said first and second substrates to resist said force, said force being applied in a sufficient amount so as to separate said first and second substrates.

According to a second aspect, there is provided an article comprising: a first substrate having a back surface and an active surface, said active surface comprising at least one active site and a plurality of topographical features; a second substrate having a bonding surface; and a thermoplastic bonding layer bonded to said active surface and to said bonding surface, wherein: said thermoplastic bonding layer is formed from a composition comprising a tackifier and a compound selected from the group consisting of rubbers, styrene-isoprene-styrene, styrene-butadiene-styrene, halogenated butyl rubber, and mixtures thereof, said tackifier and said compound being dissolved or dispersed in a solvent system, said bonding composition comprising at least 30% by weight solvent system, based upon the total weight of the composition taken as 100% by weight; said topographical features present respective end surfaces remote from the back surface of said first substrate, and at least one of the end surfaces is further from the back surface of the first substrate than the other of said end surfaces, said further end surface defining a plane that is substantially parallel to said first surface; and the distance from said plane to the bonding surface on said second substrate varying by less than 5% along said plane and second substrate bonding surface.

According to a third aspect, there is provided a composition comprising a polymer and a poly(pinene) dissolved or dispersed in a solvent system, said polymer including recurring monomers comprising cyclo-olefins.

According to a fourth aspect, there is provided a flowable, bonding composition comprising a tackifier and a polymer including recurring monomers comprising cyclo-olefins, said tackifier and polymer being dispersed or dissolved in a solvent system, said composition comprising at least 30% by weight solvent system, based upon the total weight of the composition taken as 100% by weight.

According to a fifth aspect, there is provided a flowable, bonding composition comprising: a tackifier; and a compound selected from the group consisting of rubbers, styrene-isoprene-styrene, styrene-butadiene-styrene, halogenated butyl rubber, and mixtures thereof, said tackifier and compound being dispersed or dissolved in a solvent system, said composition comprising at least 30% by weight solvent system, based upon the total weight of the composition taken as 100% by weight.

~~In one embodiment, the bonding layer is formed of a composition comprising a polymer (or polymer blend) and a tackifier such as a pinene or poly(pinene) dissolved or dispersed in a solvent system, with the polymer including recurring monomers comprising cyclo olefins.~~

~~In another embodiment, the invention provides a flowable, bonding composition comprising a tackifier and a polymer including recurring monomers comprising cyclo olefins. The tackifier and polymer are dispersed or dissolved in a solvent system that makes up at least about 30% by weight of the composition, based upon the total weight of the composition taken as 100% by weight.~~

~~In one embodiment, a flowable, bonding composition comprising a tackifier and a compound selected from the group consisting of rubbers, styrene-isoprene-styrene, styrene-butadiene-styrene, halogenated butyl rubber, and mixtures thereof is provided. The tackifier and compound are dispersed or dissolved in a solvent system that makes up at least about 30% by weight of the composition, based upon the total weight of the composition taken as 100% by weight.~~

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Figure (Fig.) 1 illustrates the inventive method of thinning and debonding two wafers according to the present invention;

Fig. 2 is a flow diagram showing the process steps followed in the examples;

Fig. 3 is a graph depicting the rheological analysis results of a bonding composition described in Example 1;

Fig. 4 is a graph depicting the rheological analysis results of a bonding composition described in Example 2;

Fig. 5 is a graph depicting the rheological analysis results of a bonding composition described in Example 3; and

Fig. 6 is a graph depicting the rheological analysis results of a bonding composition described in Example 4.