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TEMPORARY BONDING BY MEANS OF POLYELECTROLYTE LAYERS

For many applications or individual operations in microsystem technology the wafers used have now become so large and thin that they would fracture if nothing were done about it. In such cases so-called temporary wafer bonds are used. Here, for example, silicon wafers are fixed to a handling wafer for processing. It must then be possible to detach them subsequently without mechanical damage. At the Fraunhofer IST polyelectrolyte intermediate layers are used to control the adhesion of the wafers.

Bonding with conventional adhesive films

The most important area of application for temporary bonding is microsystem technology. Above all the correct choice of adhesive is of crucial importance here. Not only the mechanical properties but also the thermal and chemical stability of the adhesive must satisfy the material requirements in force in downstream processing operations.

Intermediate layers consisting of waxes or thermoplastic materials such as UV-activated adhesive films have become well-established for temporary bonding. In most cases the layers are applied by spin coating or rolled on as a laminate. Adhesion force can be controlled by temperature increase or by ultraviolet irradiation so that the wafers can then be removed subsequently by mechanical means. The thinner the wafers, the more challenging the detachment process. Usually a costly process of cleaning is then necessary before the wafers can be further processed.

Bonding with polyelectrolyte intermediate layers

In collaboration with the Institut für Oberflächentechnik of the Technical University of Braunschweig (IOT) coatings using polyelectrolytes have been developed at the Fraunhofer IST which are suitable for temporary bonding and replace the adhesive layers and adhesive films we have mentioned. Polyelectrolytes are polymers with positively or negatively charged ionic groups. In aqueous solutions they usually adsorb very strongly onto surfaces of opposite charge. In this way single-layer polyelectrolyte films are created. Polyelectrolyte multilayers (PEMs) form by the successive adsorption of positively and negatively charged polyelectrolytes. The advantage of using polyelectrolytes is that they cover the surface only as a monolayer and thus build up evenly and can be easily removed again.

Separating by annealing

Temperature-related tests of the bond strength of silicon wafers with polyelectrolyte intermediate layers have shown

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1 *Coating a wafer with a polyelectrolyte in the spin dryer.*

2 *Atmospheric-pressure plasma pretreatment of substrates for subsequent bonding.*

that strength increases as temperature rises. However, once a certain temperature is reached, strength falls abruptly and remains low even after cool-down, which means that the wafers can be easily separated. The strength level can be set by selection of the temperature during annealing within the range between 100 °C and 250 °C. This means that in the first heat-treatment step substrate wafers can be bonded firmly onto a carrier wafer and then processed. Following a second annealing step the wafers can then be easily separated from each other at room temperature.

Outlook

Future work will concentrate on controlling the separation process over the most varied temperature ranges by using further polyelectrolyte combinations. These should be optimized for different wafer materials. In addition, more fundamental investigations are planned with a view to understanding the process of separation.

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