Method for Permanent Bonding of Wafers

Specification

This invention relates to a method for bonding of a first contact surface of a first substrate to a second contact surface of a second substrate.

The objective in permanent or irreversible bonding of substrates is to produce an interconnection which is as strong and especially as irreversible as possible, therefore a high bond force, between the two contact surfaces of the substrates. There are various approaches and production methods for this purpose in the prior art.

The known production methods and the approaches which have been followed to date often lead to results which cannot be reproduced or can be poorly reproduced and which can hardly be applied especially to altered conditions. In particular, production methods which are used at present often use high temperatures, especially > 400°C, in order to ensure reproducible results.

Technical problems such as high energy consumption and a possible destruction of structures which are present on the substrates result from the high temperatures to some extent far above 300°C which have been necessary to date for a high bond force.

Other demands consist in the following:

- front-end-of-line compatibility.

  This is defined as the compatibility of the process during the production of the electrically active components. The bonding process must therefore be designed such that active components such as transistors, which are already present on the structure wafers, are neither adversely affected nor damaged during the processing. Compatibility criteria include mainly the purity of certain chemical elements (mainly in CMOS structures) and mechanical loadability, mainly by thermal stresses.

- low contamination.
- no application of force.
- temperature as low as possible, especially for materials with different coefficients of thermal expansion.

The reduction of the bond force leads to more careful treatment of the structure wafer and thus to a reduction of the failure probability by direct mechanical loading.

Embodiments of this invention disclose a method for careful production of a permanent bond with a bond force which is as high as possible at a temperature which is at the same time as low as possible.

According to an aspect of the present invention, there is provided a method for bonding of a first contact surface of a first substrate to a second contact surface of a second substrate, the method including the steps of: forming a reservoir in a surface layer on the first contact surface, the surface layer consisting at least largely of a native oxide material, at least partial filling of the reservoir with a first educt or a first group of educts, bringing the first contact surface in contact with the second contact surface for formation of a prebond connection, forming a permanent bond between the first and second contact surface, at least partially strengthened by the reaction of the first educt with a second educt contained in a reaction layer of the second substrate.

All combinations of at least two of the features given in the specification, the claims and/or the figures also fall within the framework of the invention. At the given value ranges, values within the indicated limits will also be considered to be disclosed as boundary values and will be claimed in any combination.

The basic idea as per embodiments of this invention is to disclose a reservoir for holding a first educt at least on one of the substrates, which educt reacts after making contact or producing a temporary bond between the substrates with a second educt which is present in the other substrate, and which thus forms an irreversible or permanent bond between the substrates. Before or after forming the reservoir in one surface layer on the first contact surface, generally cleaning of the substrate or substrates, especially by a flushing step, occurs. This cleaning should generally ensure that there are