Method for Permanent Bonding of Wafers

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 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 used at present often use high temperatures, especially > 400°C in order to ensure reproducible results.

Technical problems such as high energy consumption and possible destruction of structures which are present on the substrates result from the high temperatures of partially 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 the chemical elements (mainly in CMOS structures) and mechanical loadability, mainly by thermal stresses.

- low contamination.

- no application of force.

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.

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: forming a reservoir in a surface layer on the first contact surface by exposing the first contact surface to N_2 gas and/or O_2 gas and/or Ar gas and/or forming gas comprising 95% Ar and 5% H_2, at least partially filling of the reservoir with a first educt or a first group of educts, contacting the first contact surface with the second contact surface for formation of a prebond connection, and forming a permanent bond between the first and second contact surface, the permanent bond 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 disclosed as boundary values and will be claimed in any combination.

The basic idea of embodiments of this invention is to devise a reservoir for holding a first educt at least on one of the substrates, to react it after making contact or producing a temporary bond between the substrates with a second educt which is present in the other substrate, and thus to form 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 no particles on the surfaces which would result in unbonded sites. The reservoir and the educt contained in the reservoir form a technical possibility for inducing a reaction which strengthens the permanent bond and which increases the bond speed in a controlled manner directly on the contact surfaces after producing the temporary or reversible bond, especially by deforming at least one of the contact