Device and Method for Processing of Wafers

Specification

The invention relates to a device for processing of substrates or substrate pairs, especially wafers as wafer pairs~~, as claimed in Claim 1~~, and a corresponding method ~~as claimed in Claim 8~~.

Process systems or process devices of semiconductor technology are generally of modular structure. They conventionally consist of different chambers in which various process steps are carried out. Thus, for example for pretreatment of wafers, process steps such as wet cleaning, plasma treatment, etching or heating can be used, while for primary treatment of a wafer, bonding, lacquering, imprinting, embossing and exposure are possible. In known process systems the wafers or wafer stacks are transported with cassettes between the process systems or modules of process systems.

During transport, the contamination, damage, fouling or oxidation and thus influencing of other process steps can occur.

Contamination of the primary treatment chambers between treatments of successive wafers, therefore in loading and unloading of wafers, is also a problem.

Furthermore it is critical with respect to time that in the primary treatment large pressure differences from atmospheric pressure as far as very low pressures of 10^{-6} bar or less must be overcome.

Embodiments~~The object~~ of this invention ~~is therefore to~~ optimize the processing of substrates both in terms of the sequence, and also to avoid contamination, damage, fouling or oxidation as much as possible.

According to a first aspect, there is provided a device for processing of substrates or substrate pairs, with

- at least one pretreatment module for pretreating a substrate pair with a pretreatment chamber which can be exposed to a vacuum and which surrounds a pretreatment space, with a first lock door,
- at least one primary treatment module with a primary treatment chamber which can be exposed to a vacuum separately from the pretreatment chamber and which surrounds a primary treatment space, and in which the substrate pair can be brought into contact and can be bonded, while the pretreatment module can be loaded with a further substrate pair,
- a first primary lock door which connects the pretreatment chamber to the primary treatment chamber vacuum-tight, the pretreatment module being switchable as a lock for the loading of the primary treatment chamber with substrates,
- at least one aftertreatment module with an aftertreatment chamber which can be exposed to a vacuum separately from the primary treatment chamber and which surrounds an aftertreatment space, with a second lock door and
- a second primary door lock which connects the primary treatment chamber to the aftertreatment chamber vacuum-tight, the aftertreatment module being switchable as a lock for the unloading of the substrates from the primary treatment chamber,

wherein the primary lock doors are transfer valves.

According to a second aspect, there is provided a method for processing of substrates or substrate pairs, with the following steps:

- loading of a pretreatment chamber with a substrate or substrate pair via a first lock door,
- pretreatment of the substrate in the pretreatment chamber by exposure to pressure and/or temperature,
- loading of the substrate from the pretreatment chamber via a first primary door lock into primary treatment chamber which can be exposed to a vacuum,
- primary treatment of the substrate in the primary treatment chamber by exposure to pressure and/or temperature, wherein at the same time a further substrate/substrate pair can be loaded into the pretreatment chamber,
- unloading of the substrate from the primary treatment chamber via a second primary lock door into an aftertreatment chamber,
- aftertreatment of the substrate in the aftertreatment chamber and
- unloading of the substrate from the aftertreatment chamber via a second lock door,

wherein the primary lock doors are transfer valves.

~~This object is achieved with the features of Claims 1 and 8. Advantageous developments of the invention are given in the dependent claims.~~ 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.

Embodiments of tThe invention areis based on the idea of coupling a primary treatment module to at least one pretreatment module and at least one aftertreatment module such that at least one of the pretreatment modules and at least one of the aftertreatment modules and/or the primary treatment module each act as vacuum-tight locks for an adjacent pretreatment module, primary treatment module or aftertreatment module. At the same time, according to anthe invention in one embodiment of the invention, it is provided that at least one of the pretreatment modules and/or the primary treatment module and/or at least one of the aftertreatment modules can be especially exposed to pressure, a vacuum, and/or can be temperature-treated, especially can be heated independently or regardless of an adjacent module.

In this way, in spite of a flexible structure of the process system according to the device as claimed inper embodiments of the invention a time-optimized, even parallel processing of several substrates is provided within the device as claimed inper embodiments of the invention, in which based on the lock-like coupling of the individual process modules contamination, damage, fouling or oxidation by decoupling of the substrates from external effects, especially in the loading and unloading of the individual modules,

is resolved.

It is especially advantageous if the primary treatment module can be loaded and unloaded exclusively via locks or a positing system. This is achieved as ~~claimed in~~per embodiments of the invention by there being both a pretreatment module which is coupled in the manner of a lock to the primary treatment module and also an aftertreatment module which is coupled in the manner of a lock to the primary treatment module. By this measure the generally especially critical primary treatment of the substrates or wafers which occurs under often extreme conditions does not take place at any instant of the processing nor during the loading and unloading of the primary treatment module with contact with the environment. The primary treatment module is accordingly completely decoupled from the environment so that contamination, damage, fouling or oxidation during the primary treatment of the substrates is essentially precluded. Furthermore, there is the advantage that the steps preparatory and subsequent to primary treatment can be moved into the pretreatment module and the aftertreatment module, especially at least partial exposure to pressure and/or temperature. In the primary treatment module as a result of this only a lower pressure difference and/or temperature difference than from the ambient/atmospheric pressure p_{ATM} need be overcome.

According to one advantageous embodiment of the invention, it is provided that the primary treatment chamber can be switched as a lock in the loading and unloading of the substrates. Thus, when the primary treatment chamber is being loaded, at the same time aftertreatment of the substrate which has been worked beforehand in the primary treatment chamber can take place. When the primary treatment chamber is being unloaded, conversely at the same time pretreatment of the next substrate which is to be worked in the primary treatment chamber can take place in the pretreatment chamber.

In another advantageous embodiment, it is provided that the pretreatment chamber and/or the primary treatment chamber and/or the aftertreatment chamber can be heated especially separately by means of a heating apparatus. It is especially advantageous here if the pretreatment chamber and/or the primary treatment chamber and/or the aftertreatment chamber are completely heat-insulated. In this way exact temperature control is possible with heat loss as low as possible.

To the extent other correspondingly made pretreatment modules can be connected upstream to the pretreatment module as locks and/or other correspondingly made aftertreatment modules can be connected downstream of the aftertreatment module as locks, the method sequence can be further subdivided so that optimization of the passage times in the process sequence arises. Here it is conceivable as ~~claimed in~~per embodiments of the invention that at the same time several pretreatment modules are directly coupled to one pretreatment module via lock doors. In this way time-intensive pretreatment steps can proceed parallel and accordingly staggered in time in the upstream pretreatment modules. This applies analogously to the corresponding aftertreatment modules.

By the locks being made as pressure locks and/or temperature locks it is possible as ~~claimed in~~per embodiments of the invention to control the pressure and/or the temperature by corresponding switching of the pretreatment modules and/or the aftertreatment modules.

For loading and unloading, as ~~claimed in~~per embodiments of the invention there is a loading and unloading apparatus, especially at least one robot arm. The latter is used for loading and unloading of the substrates into/out of the primary treatment chamber and/or the pretreatment chamber and/or the aftertreatment chamber, and for parallel handling there can be several substrates/wafers in the process sequence, as ~~claimed in~~per embodiments of the invention several robot arms. Thus for example in each pretreatment chamber and/or each aftertreatment chamber there can be exactly one robot arm which