

All the mentioned methods and bonding devices produce a bonded substrate stack after a jointing process. However, either additional materials such as metals and/or their ions are used in all the methods or oxides and/or nitrides of the substrates are formed and bonded together.

Embodiments of the present invention remove the drawbacks of the prior art and in particular achieve a better bonding result.

All combinations of at least two of the features stated in the description, the claims and/or the drawings also fall within the scope of the invention. In the case of value ranges, values also lying within the stated limits are also intended to be disclosed as limiting values and can be claimed in any combination.

According to a first aspect of the invention, there is provided a method for bonding a first substrate with a second substrate, the method including the steps of:

- production of a first amorphous layer on the first substrate and/or production of a second amorphous layer on the second substrate,
- bonding of the first substrate with the second substrate at the amorphous layer or at the amorphous layers to form a substrate stack,
- irradiation of the amorphous layer or the amorphous layers with radiation in such a way that the amorphous layer or the amorphous layers is/are transformed into a crystalline layer or crystalline layers, wherein the amorphous layer (1a,2a,6a) or the amorphous layers in a particle energy region between about 1,8 eV and 3,0 eV has/have an absorption capacity higher by the factor 0,2 - 18 than the crystalline layer(s).

Also, according to a second aspect of the invention, there is provided a device for bonding a first substrate with a second substrate, in particular using the above method according, including:

- a receiving means for receiving the substrates,
- a bonding device for bonding the substrates,
- an irradiation device,

wherein the device is constituted in such a way

- that a first amorphous layer can be produced on the first substrate and/or a second amorphous layer can be produced on the second substrate,
- that the first substrate can be bonded with the second substrate at the amorphous layer or at the amorphous layers for the formation of a substrate stack,
- that the amorphous layer or the amorphous layers can be irradiated with radiation by means of the irradiation device, in such a way that the amorphous layer or the amorphous layers can be transformed into a crystalline layer or crystalline layers, wherein the amorphous layer (1a,2a,6a) or the amorphous layers in a particle energy region between about 1,8 eV and 3,0 eV has/have an absorption capacity higher by the factor 0,2 -18 than the crystalline layer(s).

Also, according to a third aspect of the invention, there is provided a substrate stack including at least a first substrate and a second substrate, which has been bonded using the above device and/or a the above method.

According to embodiments of the invention, two individual substrates can be bonded together. A substrate can however also be bonded with a substrate stack or two substrate stacks can be bonded together. A substrate stack comprises two or more bonded substrates.

A substrate or substrate stack to be bonded can have an amorphous layer on one side only or can have an amorphous layer on both sides.

For the purpose of simplification, substrate is always intended in the following to mean both a single substrate as well as a substrate stack, unless anything is stated to the contrary.

The basic idea of embodiments of the invention consists in the fact that good prefixing (prebonding) of the substrates is produced by the at least one amorphous

## Claims

1. A method for bonding a first substrate (1,6) with a second substrate (2), the method comprising the steps of:
  - production of a first amorphous layer (1a,6a) on the first substrate (1,6) and/or production of a second amorphous layer (2a) on the second substrate (2),
  - bonding of the first substrate (1,6) with the second substrate (2) at the amorphous layer (1a,2a,6a) or at the amorphous layers (1a,2a,6a) to form a substrate stack (3),
  - irradiation of the amorphous layer (1a,2a,6a) or the amorphous layers (1a,2a,6a) with radiation (5) in such a way that the amorphous layer (1a,2a,6a) or the amorphous layers (1a,2a,6a) is/are transformed into a crystalline layer or crystalline layers, wherein the amorphous layer (1a,2a,6a) or the amorphous layers (1a,2a,6a) in a particle energy region (A) between about 1,8 eV and 3,0 eV has/have an absorption capacity higher by the factor 0,2 -18 than the crystalline layer(s).
2. The method according to claim 1, wherein the amorphous layer(s) (1a,2a,6a) is/are transformed predominantly, preferably completely, into a crystalline layer/crystalline layers.
3. The method according to any one of the preceding claims, wherein an amorphous layer (1a,2a,6a) is produced on a predominant part of the bonding surface (1o,2o) of the substrate/substrates (1,2,6), wherein an amorphous layer (1a,2a,6a) is preferably produced on the entire bonding surface (1o,2o) of the substrate/substrates (1,2,6).
4. The method according to any one of the preceding claims, wherein at least one of the substrates (1,2,6) is transparent for the radiation (5), wherein at least 50% of the radiant energy of the radiation (5) is passed through, preferably at least 60%, particularly preferably at least 70%,

very particularly preferably at least 80%, still more preferably at least 90%.

5. The method according to any one of the preceding claims, wherein the amorphous layer (1a,2a,6a) absorbs the radiation (5) up to more than 60% of the radiant energy of the radiation (5), preferably more than 60% is absorbed, more preferably more than 70%, particularly preferably more than 80%, very particularly preferably more than 90%.
6. The method according to any one of the preceding claims, wherein the radiation (5) is laser radiation, wherein the laser radiation is focused on the amorphous layer(s) (1a,2a,6a).
7. The method according to any one of the preceding claims, wherein the radiation (5) strikes the amorphous layer(s) (1a,2a,6a) at right angles.
8. The method according to any one of the preceding claims, wherein the radiation (5) is generated by a broadband emitter, which emits in the energy range between 1 eV and 10E8 eV, preferably between 1 eV and 10E6 eV, still more preferably between 1 eV and 10E4 eV, most preferably between 1 eV and 10 eV.
9. The method according to any one of the preceding claims, wherein the radiant power of the radiation (5) lies between 0.01 Watt and 10000 Watt, preferably between 0.1 Watt and 1000 Watt, most preferably between 1 Watt and 100 Watt.
10. The method according to any one of the preceding claims, wherein temperatures of over 200°C are produced by the radiation (5) in the amorphous layer(s) (1a,2a,6a), preferably over 400°C, particularly

preferably over 600°C, still more preferably over 800°C, most preferably over 1200°C.

11. The method according to any one of the preceding claims, wherein the irradiation time lies below 30 s, preferably below 15 s, particularly preferably below 1 s, very particularly preferably below 100 ms.
12. The method according to any one of the preceding claims, wherein a reflection of the radiation (5) at the substrates surfaces and/or substrate stack surfaces amounts to less than 4 % of an output intensity of a radiation source (4), preferably less than 3 %, particularly preferably less than 1%.
13. The method according to any one of the preceding claims, wherein the first substrate (1,6) and/or the second substrate (2) is transparent for the radiation (5) up to at least 95% of an output intensity of a radiation source (4), preferably 97% transparent, particularly preferably 99% transparent.
14. The method according to any one of the preceding claims, wherein before and/or during the irradiation, heating of at least one of the substrates (1,2,6), preferably of both substrates (1,2,6), takes place, wherein the substrate(s) (1,2,6) are heated over 100°C, preferably over 200°C, particularly preferably over 300°C.
15. A device for bonding a first substrate (1,6) with a second substrate (2), in particular using a method according to any one of the preceding claims, comprising:
  - a receiving means for receiving the substrates (1,2,6),
  - a bonding device for bonding the substrates (1,2,6),

- an irradiation device (4),  
wherein the device is constituted in such a way
  - that a first amorphous layer (1a,6a) can be produced on the first substrate (1,6) and/or a second amorphous layer (2a) can be produced on the second substrate (2),
  - that the first substrate (1,6) can be bonded with the second substrate (2) at the amorphous layer (1a,2a,6a) or at the amorphous layers (1a,2a,6a) for the formation of a substrate stack (3),
  - that the amorphous layer (1a,2a,6a) or the amorphous layers (1a,2a,6a) can be irradiated with radiation (5) by means of the irradiation device (4), in such a way that the amorphous layer (1a,2a,6a) or the amorphous layers (1a,2a,6a) can be transformed into a crystalline layer or crystalline layers, wherein the amorphous layer (1a,2a,6a) or the amorphous layers (1a,2a,6a) in a particle energy region (A) between about 1,8 eV and 3,0 eV has/have an absorption capacity higher by the factor 0,2 -18 than the crystalline layer(s).
16. A substrate stack (3) comprising at least a first substrate (1,6) and a second substrate (2), bonded using a method and/or by means of a device according to any one of the preceding claims.