All the previously known techniques which measure the course of the bonding wave observe the pre-bonding process directly through the substrate or measure the effect of the force of attraction with which the substrates are joined. There is hitherto no direct, commercially available measuring method and no measuring device which can directly observe the course of the bonding wave directly in the bond interface in the case of all substrates irrespective of their material nature.

Embodiments of the present invention provide a measuring device and a method for the determination of the course and/or in particular the form of a bonding wave, with which the aforementioned drawbacks can at least largely be removed.

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 value ranges, values 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 present invention, there is provided a bonding device including a measuring device for determining a course of a bonding wave in a gap between a first substrate and a second substrate, the measuring device including: at least one transmitter located at a peripheral edge of the gap for transmitting signals in the form of electromagnetic waves along a signal path running through the gap, and at least one receiver located at the peripheral edge for receiving the signals of the signal path which are sent by the transmitter through the gap and which can change before the bonding of the first and second substrates and/or during the bonding of the first and second substrates, and an influencing means for influencing the bonding wave depending on the course of the bonding wave, wherein electromagnetic radiation is transmitted as the signals by the at least one transmitter into the gap parallel to at least one of a substrate surface of the

first substrate and a substrate surface of the second substrate to be bonded, and wherein transmissions along the at least one of the substrate surface of the first substrate and the substrate surface of the second substrate to be bonded and transmission at the gap are measured by the at least one receiver to measure lateral limits of the substrate surfaces to be bonded.

An embodiment of the invention provides a measuring device for determining a course of a bonding wave in a gap between a first substrate and a second substrate, comprising:

- at least one transmitter, which can be placed at a peripheral edge of the gap, for transmitting signals in the form of electromagnetic waves along a first signal path running through the gap and at least one further signal path running through the gap,
- at least one receiver, which can be placed at the peripheral edge, for receiving the signals of the first signal path and of the further signal path(s) which are sent by the transmitter through the gap and can change before the bonding and/or during the bonding.

Provision is preferably made such that the measuring device can be used in a bonding device, in particular in-situ.

It is also preferable that the transmitter and/or the receiver can be moved along the peripheral edge.

It is also preferable that the transmitter and/or the receiver is/are rotatable, in particular adjustably rotatable, at the peripheral edge, so that the transmitter and/or the receiver can form with one another an optimum signal path with self-adjusting value maxima.

It is also preferable that the measuring device for determining a course of a bonding wave in a gap between a first substrate and a second substrate comprises

- at least one transmitter, which can be placed at a peripheral edge of the gap, for transmitting signals in the form of electromagnetic waves along a first signal path running through the gap,
- at least one receiver, which can be placed at the peripheral edge, for receiving the signals of the first signal path which are sent by the transmitter through the gap and which can change before bonding and/or during bonding.

It is also preferable that the measuring device comprises a plurality of transmitters distributed at the peripheral edge and/or a plurality of receivers, in particular at least two receivers per transmitter, distributed at the peripheral edge, in each case assigned to a transmitter arranged in particular lying opposite.

It is also preferable that each transmitter sends, in particular simultaneously, a plurality of signal paths and/or each receiver is assigned in each case to a single signal path.

The measuring device is also preferably provided with an evaluation unit for determining measured values along the signal paths, in particular by transformation, preferably by integral transformation, preferably radon transformation, of the signals received by the at least one receiver.

Furthermore, provision is preferably made such that the at least one receiver is constituted so as to detect optical properties of the signal, in particular one or more of the following optical properties:

- refractive index
- mode of signals distinguished as transverse electromagnetic waves

- running time
- intensity
- spectral coding.

A further embodiment of the invention relates to a bonding device, comprising a measuring device according to one of the preceding embodiments.

Provision is preferably made such that the bonding device comprises influencing means for influencing the bonding wave depending on the course of the bonding wave.

A further embodiment of the invention relates to a device, comprising a measuring device which, using a method according to the invention, checks the gap, i.e. the distance between substrate surfaces not touching one another, before and/or after bonding. A use of the device can in particular check and/or influence the arrangement of two substrates coated with adhesive prior to the adhesive bonding process.

According to a second aspect of the present invention, there is provided a bonding method for determining a course of a bonding wave in a gap between a first substrate and a second substrate by means of a bonding device including at least one transmitter and at least one receiver, the method including: arranging the at least one transmitter at a peripheral edge of the gap, arranging the at least one receiver at the peripheral edge of the gap, transmitting signals in the form of electromagnetic waves by means of the transmitter or transmitters arranged at the peripheral edge along a signal path running through the gap, receiving the signals by means of the at least one receiver or receivers arranged at the peripheral edge for the reception of the signals of the signal path which are sent by the at least one transmitter(s) through the gap and which can change before bonding of the first and second

substrate and/or during bonding of the first and second substrate, and influencing the bonding wave depending on the course of the bonding wave, wherein electromagnetic radiation is transmitted as the signals by the at least one transmitter into the gap parallel to at least one of a substrate surface of the first substrate and a substrate surface of the second substrate to be bonded, and wherein transmissions along the at least one of the substrate surface of the first substrate and the substrate surface of the second substrate to be bonded and transmission at the gap are measured by the at least one receiver to measure lateral limits of the substrate surfaces to be bonded.

A further embodiment relates to a method for bonding two substrates, wherein the course of the bonding wave is determined by means of a method according to the preceding embodiment.

Provision is preferably made such that the bonding wave is influenced depending on the course of the bonding wave.

The basic idea of embodiments of the present invention is to transmit electromagnetic waves through the gap between the substrates to be bonded and to measure the change therein after passage between the substrates before and/or during the pre-bonding process, i.e. in the course of the bonding wave, in particular during the change in the position of the bonding wave. A change in the electromagnetic wave is understood to mean a change in the intensity and/or the polarisation and/or the phase etc. According to embodiments of the invention, the measurement can comprise a multiplicity of signal paths of the

Claims

1. A bonding device (10) comprising a measuring device (1) for determining a course of a bonding wave in a gap (3) between a first substrate (2) and a second substrate (4), the measuring device (1) comprising:

at least one transmitter (7) located at a peripheral edge (3u) of the gap (3) for transmitting signals (9) in the form of electromagnetic waves along a signal path running through the gap (3), and

at least one receiver (8, 8‘), located at the peripheral edge (3u) for receiving the signals (9) of the signal path which are sent by the transmitter (7) through the gap (3) and which can change before the bonding of the first and second substrates (2,4) and/or during the bonding of the first and second substrates (2,4), and

an influencing means for influencing the bonding wave depending on the course of the bonding wave,

wherein electromagnetic radiation is transmitted as the signals by the at least one transmitter (7) into the gap parallel to at least one of a substrate surface of the first substrate (2) and a substrate surface of the second substrate (4) to be bonded, and

wherein transmissions along the at least one of the substrate surface of the first substrate (2) and the substrate surface of the second substrate (4) to be bonded and transmission at the gap are measured by the at least one receiver (8, 8‘) to measure lateral limits of the substrate surfaces to be bonded.

2. The bonding device (10) according to claim 1 in which the measuring device (1) is used in-situ the bonding device (10).

3. The bonding device (10) according to at least one of the preceding claims, wherein the transmitter (7) and/or the receiver (8, 8‘) can be moved along the peripheral edge (3u).

4. The bonding device (10) according to at least one of the preceding claims, which comprises a plurality of transmitters (7) distributed at the

peripheral edge (3u) and/or a plurality of receivers (8, 8’) distributed at the peripheral edge (3u), wherein in each case, a receiver (8,8”) is assigned to a transmitter (7).

5. The bonding device (10) according to claim 4, wherein there are at least two receivers (8, 8’) per transmitter (7).

6. The bonding device (10) according claim 4 or 5, wherein a transmitter (7) lying opposite is assigned to a receiver (8, 8’).

7. The bonding device (10) according to at least one of the preceding claims, wherein each transmitter (7) transmits a plurality of signal paths and/or each receiver (8, 8‘) is assigned in each case to a single signal path.

8. The bonding device (10) according to claim 7, wherein each transmitter (7) transmits the plurality of signal paths simultaneously.

9. The bonding device (10) according to at least one of the preceding claims with an evaluation unit for determining measured values along the signal paths of the signals (9) received by the at least one receiver (8, 8‘).

10. The bonding device (10) according to claim 9, wherein the measured values are determined by a transformation.

11. The bonding device (10) according claim 10, wherein the transformation is a radon transformation.

12. The bonding device (10) according to at least one of the preceding claims, wherein the at least one receiver (8, 8’) is constituted detecting optical properties of the signals (9).

13. The bonding device (10) according to claim 12, wherein the optical properties comprise one or more of double refraction, refractive index, mode

of signals distinctive as transverse electromagnetic waves, running time and spectral coding.

14. A bonding method for determining a course of a bonding wave in a gap (3) between a first substrate (2) and a second substrate (4) by means of a bonding device (10) including at least one transmitter (7) and at least one receiver (8, 8'), the method comprising:

arranging the at least one transmitter (7) at a peripheral edge (3u) of the gap (3),

arranging the at least one receiver (8, 8') at the peripheral edge (3u) of the gap (3),

transmitting signals (9) in the form of electromagnetic waves by means of the transmitter or transmitters (7) arranged at the peripheral edge (3u) along a signal path running through the gap (3),

receiving the signals (9) by means of the at least one receiver or receivers (8, 8‘) arranged at the peripheral edge (3u) for the reception of the signals (9) of the signal path which are sent by the at least one transmitter(s) (9) through the gap (3) and which can change before bonding of the first and second substrates (2,4) and/or during bonding of the first and second substrates (2,4), and

influencing the bonding wave depending on the course of the bonding wave,

wherein electromagnetic radiation is transmitted as the signals by the at least one transmitter (7) into the gap parallel to at least one of a substrate surface of the first substrate (2) and a substrate surface of the second substrate (4) to be bonded, and

wherein transmissions along the at least one of the substrate surface of the first substrate (2) and the substrate surface of the second substrate (4) to be bonded and transmission at the gap are measured by the at least one receiver (8, 8‘) to measure lateral limits of the substrate surfaces to be bonded.