Method for Bonding of Substrates

Specification

This invention relates to a method for bonding of a first contact area of a first substrate which is largely transparent at least to a certain wavelength range to a second contact area of a second substrate which is largely transparent at least to a certain wavelength range, a method for producing a first substrate and a method for producing a second substrate.

The generic methods are used especially to produce multilayer semiconductor, glass or ceramic composites. One especially important application relates to the production of multilayer photovoltaic cells.

One of the main limitations in the production of multilayer cells is the incompatibility of the lattice structures of the individual semiconductor materials with respect to their dimension and shape. In the production of the individual layers by direct growth of layers on one another this leads to defects in the semiconductor layer which has been implemented with it. These defects adversely affect the quality of the produced layer and especially the attainable efficiency for the conversion of light into electrical energy. Limitations with respect to the following parameters result from this in practice:

a) the number of attainable active layers in the structure. This is limited at present to 2 to a maximum three layers due to the above described problems.

b) optimization of the individual layers with respect to the optimum wavelength range. In practice it is not currently possible to optimize the individual layers completely freely with respect to the optimum wavelength range and associated conversion characteristics for the conversion of light into electrical energy, since compromises must always be reached with respect to the compatibility of the lattice structure.

c) use of more favorable materials: For certain wavelengths it would be desirable to use for example silicon or germanium since these materials would allow an ideal compromise between efficiency and costs. Often the use of these materials is however not possible since the lattice structure is not adequately compatible with the other structures which are used in the cell.

Embodiments of this invention disclose a method with which the production of the aforementioned multilayer composites more efficiently and with more diverse parameters is enabled.

According to a first aspect of the present invention, there is provided a method for bonding of a first contact area of a first at least largely transparent substrate to a second contact area of a second at least largely transparent substrate, on at least one of the contact areas an oxide being used for bonding, from which an at least largely transparent interconnection layer is formed with: an electrical conductivity of at least 10e1 S/cm (measurement: four point method, relative to temperature of 300K) and an optical transmittance greater than 0.8 for a wavelength range from 400 nm to 1500 nm on the first and second contact area, application of a first oxide layer with the aforementioned electrical conductivity and the aforementioned optical transmittance to the first substrate, application of a second oxide layer to the second substrate, plasma activating at least one of the substrates, and bonding of the substrates at room temperature.

According to a second aspect of the present invention, there is provided a method for producing a first substrate with a first contact area for bonding to a second contact area of a second substrate, wherein an upper surface of the first contact area comprises a first oxide layer with: an electrical conductivity of at least $10e^{1}$ S/cm (measurement: four point method, relative to temperature of 300K) and an optical transmittance greater than 0.8for a wavelength range from 400 nm to 1500 nm being applied to the first substrate, application of a first oxide layer with the

aforementioned electrical conductivity and the aforementioned optical transmittance to the first substrate, application of a second oxide layer to the second substrate, plasma activating at least one of the substrates, and bonding of the substrates at room temperature.

According to a third aspect of the present invention, there is provided a method for producing a second substrate with a second contact area for bonding to a first contact area of a first substrate, with the following steps, especially the following sequence: application of a second oxide layer to the second substrate, application of a third oxide layer to the second oxide layer, the third oxide layer having an oxygen volume S_1 which is smaller than 70% of the maximum oxygen volume S_{max} of the third oxide layer and application of a fourth oxide layer to the third oxide layer, application of a first oxide layer with the electrical conductivity and the optical transmittance of claim 1 to the first substrate, plasma activating at least one of the substrates, and bonding of the substrates at room temperature.

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 invention is based on the idea of bonding two substrates instead of growing two layers and being able to provide several layers with different (especially optical) properties by the bonding.

The invention is based especially on the approach of producing the individual layers located in the cell structure, especially the interconnection layer which is intended for bonding, on separate