# Aluminium oxide-based metallisation barrier

The present invention relates to aluminium oxide-based passivation layers which simultaneously act as diffusion barrier for underlying wafer layers against aluminium and other metals. Furthermore, a process and suitable compositions for the production of these layers are described.

Ever-thinner solar wafers (current thickness 200 – 180 µm with a strong trend towards 160 µm) are causing ever more-pressing problems in conventional full-area metallisation on the back. On the one hand, the surface recombination speed in the strongly aluminium-doped layer is very high (typically 500 – 1000 cm/s) and cannot be reduced further as desired by means of the existing conventional technology. The consequence is a lower power output compared with more advanced, but also more expensive concepts, which is principally evident from lower short-circuit currents and reduced open terminal voltage. On the other hand, the full-area metallisation and the requisite firing process for this purpose, which takes place at peak temperatures of between 800°C and 950°C, result, owing to different coefficients of thermal expansion, in considerable stresses at the interface between the back electrode and the silicon substrate and so-called "bow" which sometimes propagates therein. This can typically be up to 6 mm in finished solar cells. This "bow" has an extremely disadvantageous effect during subsequent module assembly of the solar cells since a significantly increased breakage rate during manufacture is associated therewith.

Novel solar-cell concepts have been considerably modified compared with the conventional manufacture of solar cells and modules. This has advantageous and far-reaching effects. On the one hand, most concepts considerably increase the average efficiency achieved by the individual cells and modules. On the other hand, most concepts result in a lower material requirement for silicon (which, in the form of wafers, can make up up to 70% of the costs in the manufacture of solar cells).

In contrast to the conventional solar cell, which has virtually full-area metallisation on the back, some of the novel cell concepts are based on local metallisation of the back, which is generally taken to mean the so-called

**Metallisation barrier based on aluminium oxide**

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# PATENT CLAIMS

1. Process for the production of a dielectric layer which acts as passivation layer and diffusion barrier against aluminium and/or other related metals and metal pastes, characterised in that an aluminium oxide sol or an aluminium oxide hybrid sol in the form of an ink or paste is applied over the entire surface or in a structured manner and is compacted and dried by warming at elevated temperatures, forming amorphous $Al_2O_3$ and/or aluminium oxide hybrid layers.

2. Process according to Claim 1, characterised in that amorphous $Al_2O_3$ and/or aluminium oxide hybrid layers having a thickness of < 100 nm are formed.

3. Process according to Claim 1, characterised in that the aluminium oxide sol or aluminium oxide hybrid sol is applied and dried a number of times in order to form an amorphous $Al_2O_3$ and/or aluminium oxide hybrid layer having a thickness of at least 150 nm.

4. Process according to one of Claims 1, 2 and 3, characterised in that the drying is carried out at temperatures between 300 and 1000°C, preferably in the range between 350 and 450°C.

5. Process according to one of Claims 1 to 4, characterised in that the drying of an applied layer is carried out within a time of two to five minutes.

6. Process according to one or more of Claims 1 to 5, characterised in that the applied and dried layer(s) is (are) passivated by subsequent annealing at 400 to 500°C in a nitrogen and/or forming-gas atmosphere.

7. Process according to one or more of Claims 1 to 6, characterised in that aluminium oxide inks or aluminium oxide pastes based on the sol-gel process are applied which comprise at least one precursor, serving for doping, for the formation of an oxide of boron, gallium, silicon,

germanium, zinc, tin, phosphorus, titanium, zirconium, yttrium, nickel, cobalt, iron, cerium, niobium, arsenic or lead.

8. Process according to one or more of Claims 1 to 7, characterised in that boron doping of a silicon layer is carried out by drying an applied layer of a boron-containing aluminium oxide ink or paste at elevated temperature.

9. Process according to Claim 8, characterised in that boron doping is carried out with emitter formation in the silicon.

10. Process according to one or more of Claims 1 to 7, characterised in that phosphorus doping of a silicon layer is carried out by drying an applied layer of a phosphorus-containing aluminium oxide ink or paste at elevated temperature.

11. Dielectric aluminium oxide layer having passivation properties for p-doped base layers, obtainable by a process according to Claims 1 – 9.

12. Dielectric layer which acts as diffusion barrier against aluminium and other related metals, obtainable by a process according to Claims 1 – 6.

CLAIMS

1. A process for the production of a dielectric layer which acts as a passivation layer and diffusion barrier against aluminium and/or other related metals and metal pastes, wherein an aluminium oxide sol or an aluminium oxide hybrid sol in the form of an ink or paste is applied to a surface and is compacted and dried by warming at a temperature in the range of 350 to 450°C, wherein the applied and dried layer is passivated by subsequent annealing at 400 to 500°C in a nitrogen and/or forming-gas atmosphere, forming an amorphous $Al_2O_3$ and/or aluminium oxide hybrid layer.

2. A process according to Claim 1, wherein the ink or paste is applied to the entire surface.

3. A process according to Claim 1, wherein the ink or paste is applied in a structured manner.

4. A process according to any one of Claims 1 to 3, wherein an amorphous $Al_2O_3$ and/or aluminium oxide hybrid layer with a thickness of < 100 nm is formed.

5. A process according to any one of Claims 1 to 4, wherein the aluminium oxide sol or aluminium oxide hybrid sol is applied and dried a number of times in order to form an amorphous $Al_2O_3$ and/or aluminium oxide hybrid layer having a thickness of at least 150 nm.

6. A process according to any one of Claims 1 to 5, wherein the drying of an applied layer is carried out within a time of two to five minutes.

7. A process according to any one of Claims 1 to 6, wherein an aluminium oxide ink or aluminium oxide paste based on the sol gel process is applied, which comprises at least one precursor, serving for doping, for the formation of an oxide of boron, gallium, silicon, germanium, zinc, tin, phosphorus, titanium, zirconium, yttrium, nickel, cobalt, iron, cerium, niobium, arsenic or lead.

8. A process according to any one of Claims 1 to 7, wherein boron doping of a silicon layer is carried out by drying an applied layer of a boron-containing aluminium oxide ink or paste at elevated temperature.

9. A process according to Claim 8, wherein boron doping is carried out with emitter formation in the silicon.

10. A process according to any one of Claims 1 to 7, wherein phosphorus doping of a silicon layer is carried out by drying an applied layer of a phosphorus-containing aluminium oxide ink or paste at elevated temperature.

11. A dielectric aluminium oxide layer having passivation properties for p-doped base layers, obtainable by a process according to any one of Claims 1 to 10.

12. A dielectric layer which acts as diffusion barrier against aluminium and other related metals, obtainable by a process according to any one of Claims 1 to 10.