CLAIMS

1. A tandem photovoltaic device, comprising, in this superimposition order:

A/ a silicon-based sub-cell A comprising at least:

- a substrate made of crystalline silicon; and

- at least one layer, distinct from said substrate, made of N- or P-doped amorphous or polycrystalline silicon;

and B/ a perovskite-based sub-cell B, comprising at least:

- an N-type conductive or semiconductor layer;

- a P-type conductive or semiconductor layer; and

- a perovskite-type layer that is active from a photovoltaic point of view, interposed between said N-type and P-type conductive or semiconductor layers,

wherein said N-type conductive or semiconductor layer is based on individualised nanoparticles of N-type metal oxide(s), and has an atomic carbon content lower than or equal to 20%,

the active layer being in contact with the N-type metal oxide individualised nanoparticles.

2. The tandem photovoltaic device according to the preceding claim, wherein said sub-cell A is a silicon heterojunction sub-cell or a TOPCon-type architecture sub-cell.

3. The tandem photovoltaic device according to claim 1, wherein said sub-cell A is a silicon heterojunction sub-cell, comprising, in this stacking order:

- a first electrode denoted $E1^A$;

- a layer made of N-doped or P-doped amorphous silicon;

- said substrate made of crystalline silicon;

- a layer made of P-doped or N-doped amorphous silicon; and

- optionally, a second electrode $E2^A$.

4. The tandem photovoltaic device according to claim 1, wherein said sub-cell A is a TOPCon-type architecture sub-cell, comprising:

- said substrate made of N- or P-doped crystalline silicon;

- at the face of the substrate intended to form the rear face of the tandem photovoltaic device, a layer made of highly N+ or P+ doped polycrystalline silicon, said layer made of highly doped polycrystalline silicon being separated from said substrate by a passivation layer made of oxide so-called “tunnel oxide”;

- on the side of the opposite face of the substrate, at least one layer made of highly P+ or N+ doped crystalline or polycrystalline silicon of the electrical type opposite to that of the substrate.

5. The tandem photovoltaic device according to claim 1, wherein said N-type metal oxide nanoparticles are selected from among particles of zinc oxide, titanium oxides TiO_x with x comprised between 1 and 2, tin oxide, doped zinc oxides, doped titanium oxides; and mixtures thereof.

6. The tandem photovoltaic device according to claim 1, wherein said metal oxide nanoparticles have an average particle size comprised between 2 and 100 nm.

7. The tandem photovoltaic device according to claim 1, wherein said N-type conductive or semiconductor layer of the sub-cell B has an atomic carbon content lower than or equal to 17%.

8. The tandem photovoltaic device according to claim 1, wherein said perovskite-type active layer of the sub-cell B is formed by a perovskite material of formula ABX_3, with:

A representing a cation or a combination of metallic or organic cations;

.B representing one or more metallic element(s), chosen among lead, tin, bismuth and antimony; and

. X representing one or more halide(s) anion(s);

said perovskite material of formula $Cs_xFA_{1-x}Pb(I_{1-y}Br_y)_3$ with $x<0.17$; $0<y<1$ and FA symbolising the formamidinium cation.

9. The tandem photovoltaic device according to claim 1, wherein said perovskite-based sub-cell B comprises, in this stacking order:

- optionally a first electrode $E1^B$;

- said lower conductive or semiconductor layer of the N type in the case of a NIP structure or of the P type in the case of a PIN structure;

- said perovskite-type active layer;

- said upper conductive or semiconductor layer of the P type in the case of a NIP structure or of the N type in the case of a PIN structure,

said N-type layer being based on individualised nanoparticles of N-type metal oxide(s), and has an atomic carbon content lower than or equal to 20%,

- a transparent second electrode, called the upper electrode, $E2^B$, and more particularly formed of a layer made of metallised transparent conductive oxide.

10. The tandem photovoltaic device according to claim 3, said device being of the HET/perovskite type with a 2T structure, comprising, in this superimposition order, at least:

- a sub-cell A as described according to claim 3, comprising in this superimposition order:

. said first electrode denoted $E1^A$;

. said layer made of N-doped or P-doped amorphous silicon;

. said substrate made of crystalline silicon;

. said layer made of P-doped or N-doped amorphous silicon;

- an electronically conductive or semiconductor intermediate layer, called “recombination layer”;

- a sub-cell B as defined in claim 9, comprising in this superimposition order:

. said lower conductive or semiconductor layer of the N type in the case of a NIP structure or of the P type in the case of a PIN structure;

. said perovskite-type active layer;

. said upper conductive or semiconductor layer of the P type in the case of a NIP structure or of the N type in the case of a PIN structure, and

. said second electrode, called the upper electrode, $E2^B$.

11. The device according to claim 1, wherein the N-type metal oxide individualised nanoparticles are made of SnO_2.

12. A method of manufacturing a tandem photovoltaic device according to claim 1, comprising at least the following steps:

(a) making said silicon-based sub-cell A; and

(b) making said sub-cell B *via* at least one step of forming said N-type conductive or semiconductor layer from a dispersion of N-type metal oxide nanoparticles in a solvent medium, at a temperature lower than or equal to 150°C, and in operating conditions adjusted so as to obtain the desired atomic carbon content in said N layer, lower than or equal to 20%

and a step during which the active layer is formed over the surface of the N-type metal oxide nanoparticles.

13. The method according to claim 12, wherein said N-type conductive or semiconductor layer is formed at a temperature lower than or equal to 120°C.

14. The method according to claim 12, wherein the carbon content in said N-type conductive or semiconductor layer is controlled by adjusting the level of carbon precursor compounds of the implemented dispersion of metal oxide nanoparticles.

15. The method according to claim 12, wherein the carbon content in said N-type conductive or semiconductor layer is controlled, by subjecting, after deposition of said dispersion of metal oxide nanoparticles and prior to the deposition of the overlying layer, the N-type layer to a treatment for eliminating carbon.

16. The method according to claim 15, wherein the treatment for eliminating carbon is a treatment by UV irradiation, by UV-ozone, with ozone or by plasma.