

CLAIMS

1. An electrically conductive adhesive composition, free of metals and metal salts comprising:
- 5 - an adhesive component selected from the group consisting of polyethylene-vinyl acetate, polyolefin elastomers, polyvinyl butyral, polyacrylic acid, polyacrylates and poly(methyl methacrylate) in quantities of 5% to 40% by weight and
- an electrically conductive component comprising acetylene or carbon black nanoparticles, carbon nanotubes and flakes or plates of graphene or graphene derivatives in quantities of
- 10 60 to 95% by weight, the percentages by weight being referred to 100 parts by weight of the adhesive component and electrically conductive component,
- wherein said electrically conductive component consists of:
- acetylene or carbon black nanoparticles from 15 to 45% by weight,
- carbon nanotubes from 5 to 25% by weight, and
- 15 - flakes or plates of graphene or graphene derivatives from 35 to 70% by weight,
- the percentages by weight being referred to 100 parts by weight of said electrically conductive component,
- a solvent compatible with the polymer component in quantities of 50% to 90% by weight referred to 100 parts of the composition consisting of polymer component, electrically
- 20 conductive component and solvent.
2. Adhesive composition according to claim 1, characterized in that said graphene derivative is reduced graphene oxide.
- 25 3. Adhesive composition according to claim 1, characterized in that said electrically conductive component consists of:
- acetylene black nanoparticles from 35 to 45% by weight,
- carbon nanotubes from 10 to 20% by weight, and
- graphene flakes from 35 to 45% by weight,
- 30 the percentages by weight being referred to 100 parts by weight of said electrically conductive component.

4. Adhesive composition according to any one of the preceding claims, characterized in that it comprises from 20 to 30% by weight of adhesive polymer component and from 70 to 80% by weight of electrically conductive component, the percentages by weight being referred to 100 parts by weight of adhesive component and electrically conductive component.

5. Adhesive composition according to any one of the preceding claims, in the form of a curable paste, wherein said solvent is selected from the group consisting of chlorobenzene, xylene, chloroform, acetic acid, cyclohexanone, butanol, dimethylformamide, N-methylpyrrolidone, dimethylsulfoxide, nitroethane, toluene, ethyl acetate, chlorobenzene, cyclohexanone, isopropanol, ethanol and water and their mixtures.

6. Adhesive composition according to any one of claims 1 to 5, characterized in that the adhesive component is selected from polyethylene-vinyl acetate and elastomer polyolefins and the solvent is selected from the group consisting of chlorobenzene, xylene, chloroform and their mixtures.

7. Adhesive composition according to any one of claims 1 to 5, characterized in that the adhesive polymer component is polyvinyl butyral and the solvent is selected from the group consisting of acetic acid, butanol, cyclohexanone, dimethylsulfoxide, dimethylformamide and N-methylpyrrolidone and their mixtures.

8. Adhesive composition according to any one of claims 1 to 5, characterized in that the adhesive component is a polymethyl methacrylate and the solvent is selected from the group consisting of ethyl acetate, nitroethane, toluene, chloroform, chlorobenzene and cyclohexanone and their mixtures.

9. Adhesive composition according to any one of claims 1 to 5, characterized in that the adhesive polymer component is selected from poly(acrylic acid) and the solvent is selected from isopropyl alcohol, ethanol and their mixtures.

10. Adhesive composition according to any one of claims 1 to 5, characterized in that the

solvent has a vapor pressure higher than 0.8 kPa.

11. Process for the preparation of an adhesive composition according to any one of claims 1 to 10, characterized in that it comprises the steps of:

- 5 - melting said polymer component and dissolving or dispersing it in a solvent compatible with it, and
 - mixing the conductive component with the polymer component in said solvent at a temperature between 40 and 60°C to obtain a paste.

10 12. Use of an electrically conductive adhesive composition according to any one of claims 1 to 10 for the connection even at low temperature ($< 100\text{ }^{\circ}\text{C}$) of a copper ribbon to the Ag busbar in silicon-based heterojunction solar cells.

15 13. Use of an adhesive composition according to any one of claims 1 to 10 for the production at a temperature below $100\text{ }^{\circ}\text{C}$, including room temperature, of carbon-based back-electrodes in perovskite solar cells.

20 14. Use of an adhesive composition according to any one of claims 1 to 10 for the mechanical and electrical serial type connection of electrodes in batteries, supercapacitors and multi-component electronic systems.