CLAIMS

1. A method of forming an aluminum-doped zinc oxide film, the method comprising:

   forming a seed layer on a substrate by a solution deposition process;

   forming a mixture comprising zinc oxide, zinc nitrate and ammonium hydroxide by mixing ammonium citrate, ammonium nitrate and zinc oxide powder;

   adding a basic solution to the mixture so that a pH value of the mixture is at least 11;

   stirring the mixture after adding the basic solution to the mixture;

   filtering the mixture to form a precursor solution comprising zinc nitrate and ammonium hydroxide;

   depositing the precursor solution on the seed layer after filtering the mixture; and

   contacting the precursor solution with aluminum metal at a temperature equal to or less than 85 °C;

   wherein the aluminum-doped zinc oxide film is formed from the precursor solution and the aluminum metal.

2. The method according to claim 1,

   wherein the seed layer comprises zinc oxide.

3. The method according to claim 2,

   wherein forming the seed layer comprises:

   depositing a dispersion comprising zinc oxide nanoparticles on the substrate; and

   heating the deposited zinc oxide nanoparticles to form the seed layer.

4. The method according to claim 3,

wherein depositing the dispersion on the substrate comprises spin coating or dip coating the substrate with the dispersion.

5. The method according to claim 1,

wherein the seed layer comprises aluminum-doped zinc oxide.

6. The method according to claim 1,

wherein the basic solution is ammonium hydroxide.

7. The method according to any one of claims 1 to 6,

wherein the method is carried out in a non-vacuum environment.

8. The method according to any one of claims 1 to 7,

wherein the substrate comprises glass.

9. The method according to any one of claims 1 to 7,

wherein the substrate comprises polyethylene terephthalate (PET).

10. The method according to any one of claims 1 to 9,

wherein depositing the precursor solution and contacting the precursor solution with the aluminum metal is carried out for a duration of any value within a range from 30 minutes to 120 minutes.

11. The method according to any one of claims 1 to 10,

wherein the aluminum-doped zinc oxide film has a thickness of any value within a range from 60 nm to 80 nm.