CLAIMS

1. A method for forming a low emissivity doped zinc oxide (ZnO) film on a transparent substrate in combination with a heat absorbing polycarbonate in a laminate design, comprising:

depositing a ZnO seed layer on the transparent substrate to form a ZnO seeded substrate, wherein the transparent substrate is borosilicate glass or polycarbonate;

immersing the ZnO seeded substrate in a container containing a precursor solution, wherein the precursor solution comprises zinc nitrate hexahydrate, zinc acetate, zinc sulphate, or other zinc containing chemicals dissolved in deionized water, sodium citrate, ammonium citrate, or citric acid, and a dopant for the ZnO film;

adjusting the pH of the precursor solution to a range of between 10-12;

placing the container in an autoclave and heating the autoclave in an oven at 100 °C or less to deposit doped ZnO film on the transparent substrate, wherein the doped ZnO film has a film resistivity of at least 10^{-3} Ωcm and at most 10 Ωcm;

drying the deposited doped ZnO film; and

combining the deposited doped ZnO film with the heat absorbing polycarbonate, wherein the thus-formed low emissivity transparent substrate has a ratio of visible light transmittance (VLT) to solar heat gain factor (G) (VLT/G) of at least 1.15 and having G of at most 0.61.

2. The method of claim 1, further comprising annealing the doped ZnO film after drying at between 200 °C and 600 °C.

3. The method of claim 2, wherein the annealing comprises annealing the doped ZnO film in a box furnace for 1 h in air at 300 °C.

4. The method of any one of claims 1-3, wherein heating the autoclave comprises heating the autoclave in the oven at 90 °C.

5. The method of claim 4, wherein heating the autoclave comprises heating the autoclave in the oven at 90 °C for 4 h.

6. The method of any one of claims 1-5, wherein depositing the ZnO seed layer comprises thermal decomposition, atomic layer deposition, sputtering, spin-coating of nanoparticles, or sol-gel deposition.

7. The method of claim 6, wherein depositing the ZnO seed layer comprises thermally decomposing zinc acetate, zinc nitrate, zinc sulphate, or other zinc containing chemicals in an oven.

8. The method of claim 7, wherein depositing the ZnO seed layer comprises thermally decomposing zinc acetate, zinc nitrate, zinc sulphate, or other zinc containing chemicals in an oven at between 200 °C and 600 °C, preferably at 350 °C for 90 min.

9. The method of any one of claims 1-8, wherein the doped ZnO film is gallium (Ga) doped ZnO film, indium (In) doped ZnO film, or aluminium (Al) doped ZnO film.

10. The method of claim 9, wherein the dopant is a gallium salt.

11. The method of claim 10, wherein the dopant is gallium nitrate.

12. The method of any one of claims 1-11, wherein the pH of the precursor solution is adjusted to 10.9 with a base.

13. A low emissivity transparent substrate in combination with a heat absorbing polycarbonate in a laminate design comprising:

a transparent substrate, wherein the transparent substrate is borosilicate glass or polycarbonate; and

a doped zinc oxide (ZnO) film formed on the transparent substrate with the heat absorbing polycarbonate according to any one of claims 1-12, wherein the doped ZnO film has a film resistivity of at least 10^{-3} Ωcm and at most 10 Ωcm.

14. The low emissivity transparent substrate of claim 13, having a ratio of visible light transmittance (VLT) to solar heat gain factor (G) (VLT/G) of at least 1.15 and having G of at most 0.61.

15. The low emissivity transparent substrate of claim 13 or 14, wherein the doped ZnO film has a carrier concentration of at least 10^{19} cm^{-3}.