CLAIMS

1. A treatment method of a sapphire material, said method comprising bombardment of a surface of the sapphire material, said surface facing a medium different from the sapphire material, by a single- and/or multi-charged gas ion beam so as to produce an ion implanted layer in the sapphire material, wherein:

- the dose of implanted single- and/or multi-charged gas ions per unit of surface area is chosen in a range between 10^{12} ions/cm^2 and 10^{18} ions/cm^2; and,
- the acceleration voltage is chosen in a range between 5kV and 1000 kV;
- the dose of implanted single- and/or multi-charged gas ions and the acceleration voltage are further chosen so that to obtain an anti-glare treatment in the visible range ; and,
- wherein the ions of the single- and/or multi-charged gas ions are selected from ions of the elements from the list consisting of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), silicon (Si), phosphorus (P) and sulphur (S); and

wherein

- the dose of implanted single- and/or multi-charged gas ions per unit of surface area is chosen so as to obtain an atomic concentration of ions in the implanted layer such that the refractive index n of the implanted layer is approximately equal to $(nA.nS)^{1/2}$, for example is greater or equal to $0.8x(nA.nS)^{1/2}$ and equal or less to $1.2x(nA.nS)^{1/2}$, where nA is the refractive index of air and nS the refractive index of sapphire material;
- the acceleration voltage is chosen so as to obtain an implanted layer thickness, e, which is greater or equal to $0.75x\ p.\lambda/(4.nL)$ and equal or less to $1.25x\ p.\lambda/(4.nL)$, for example equal to $p.\lambda/(4.nL)$, where:
  - e is the implanted layer thickness corresponding to an implantation zone where the atomic concentration of implanted

single- and/or multi-charged gas ions is greater than or equal to 1% and wherein e is expressed in nanometer;

- p is a non nil positive integer;
- λ is the incident wavelength, wherein λ is expressed in nanometer, for example λ is equal to 560 nm; and,
- nL is the refractive index of the ion implanted layer, for example nL is equal to 1.4.

2. The treatment method of claim 1, wherein the ions of the single- and/or multi-charged gas ions are selected from ions of the elements from the list consisting of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), nitrogen (N) and oxygen (O), for example from the list consisting of nitrogen (N) and oxygen (O).

3. The treatment method of any of preceding claims wherein ions for bombardment by a single- and/or multi-charged gas ion beam are produced by an electron cyclotron resonance (ECR) source.

4. The treatment method of any of preceding claims wherein the ions of the gas beam are single- and multi-charged and comprises 10% multi-charged ions or more than 10% multi-charged ions.

5. The treatment method of any of preceding claims wherein the acceleration voltage is chosen to obtain an implanted layer thickness comprised between 75.p and 125.p, for example equal to 100.p, expressed in nm, where p is a non nil positive integer.

6. The treatment method of any of preceding claims wherein the dose of implanted single- and/or multi-charged gas ions per unit of surface area is chosen to obtain an atomic concentration of implanted ions greater or equal

to 5% and equal or less than 20%, as for example greater or equal to 9.5% and equal or less than 10.5%.

7. The treatment method of any of preceding claims wherein the sapphire material is movable in relation to the single- and/and multi-charged gas ion beam at a speed, V_D, between 0.1 mm/s and 1000 mm/s.

8. The treatment method of preceding claim wherein the same zone of sapphire material is moved under the single- and/or multi-charged gas ion beam along a plurality, NP, of passes at the speed V_D.

9. The treatment method of any of preceding claims wherein the dose of implanted single- and/or multi-charged gas ions per unit of surface area is chosen in a range between 10^{16} ions/cm^2 and 10^{18} ions/cm^2, for example is chosen in a range between 2.10^{16} ions/cm^2 and 2.10^{17} ions/cm^2.

10. The treatment method of any of preceding claims wherein the acceleration voltage is chosen in a range between 10 kV and 100 kV.

11. The treatment method of any of preceding claims wherein the dose of implanted single- and/or multi-charged gas ions and the acceleration voltage are further chosen according to additional choice rules.

12. The treatment method of preceding claim wherein the additional choice rules comprise using data gathered in a step prior to bombardment by a single- and/or multi-charged gas ion beam of the sapphire material to be treated, wherein:

- said step consists in choosing one type of single- and/or multi-charged ions of the elements from the list consisting of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), silicon (Si), phosphorus (P) and sulphur (S), performing a plurality of experiments with sapphire materials similar to the one to be treated by using said ions to be

bombarded and varying the implanted single- and/or multi-charged gas ion dose per unit of surface area and the acceleration voltage until determining desired implanted single- and/or multi-charged gas ion dose per unit of surface area ranges and acceleration voltage ranges so as to produce an ion implanted layer to obtain a desired anti-glare treatment in the visible range;

- choosing a single- and/or multi-charged gas ion dose per unit of surface area and an acceleration voltage value within the ranges of the preceding step and treating the sapphire material to be treated with said ions said values.

13. The treatment method of claim 11 wherein the additional choice rules comprise:

- choosing one type of single- and/or multi-charged ions of the elements from the list consisting of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), silicon (Si), phosphorus (P) and sulphur (S);

- choosing a single- and/or multi-charged gas ion dose per unit of surface area and an acceleration voltage value according to a calculation based on an ion implantation profile according to the implantation depth for the chosen ions, where said ion implantation profile has been previously be calculated or determined for a plurality of acceleration voltages so as to produce an ion implanted layer to obtain a desired anti-glare treatment in the visible range, so as to obtain an atomic concentration of implanted ions greater or equal to 5% and equal or less than 20%, as for example greater or equal to 9.5% and equal or less than 10.5%.

14. The treatment method of claim 11 wherein the additional choice rules comprise:

- choosing one type of single- and/or multi-charged ions of the elements from the list consisting of helium (He), neon (Ne), argon (Ar),

krypton (Kr), xenon (Xe), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), silicon (Si), phosphorus (P) and sulphur (S);

- choosing a single- and/or multi-charged gas ion dose per unit of surface area and an acceleration voltage value according to following equation:

$$0.02 \leq D.C^2/(T.\Delta n) \leq 2;$$ wherein:

- D is a single- and/or multi-charged gas ion dose per unit of surface area value to be chosen, expressed in 10^{16} ions/cm^2;
- C = M/15, where M is the atomic mass the chosen ion.
- T is an acceleration voltage to be chosen, expressed in kV;
- Δn is the refractive index difference between the refractive index, nS, of the sapphire material to be treated and the refractive index, nM, of the medium facing the surface to be ion bombarded of the sapphire material.

15. The treatment method of preceding claim wherein $D.C^2/(T.\Delta n)$ is greater or equal to 0.1, as for example greater or equal to 0.5, and/or equal or less than 1, as for example equal or less than 0.8.

16. A part made of synthetic sapphire material comprising at least one surface with implanted ions according to any of preceding claims, wherein the reflection of an incident wave in the visible range is reduced at least by one third, as for example by one half, when compared to the reflection of an incident wave in the visible range on the untreated sapphire material, such as for example a wavelength of the incident wave of 560 nm.

17. Use of the treatment method according to any of the claims 1 to 15, for treating a solid part made of synthetic sapphire material chosen from the list consisting of a screen, such as for example a touch screen, a window, a watch glass, a light emitting device (LED) part, a lighting device part, an optical component, such as for example device lens.

18. A synthetic sapphire material comprising at least one surface with implanted ions of the elements from the list consisting of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), silicon (Si), phosphorus (P) and sulphur (S), wherein the reflection of an incident wave in the visible range on said surface is equal or less to 2%, as for example equal or less to 1%, when measured at a 560 nm wavelength.

19. A capacitive touch panel having a high transmission in the visible range comprising:

a) a front face made of a sapphire material where the front side of the sapphire material has been ion bombarded by using an ion beam wherein the ions are chosen from the ions of the atoms from the list consisting of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), silicon (Si), phosphorus (P) and sulphur (S);

b) a capacitive touch detection layer,

c) a display screen.

20. The capacitive touch panel of claim 19 wherein the front side of the sapphire material has a thickness equal to or less than 1 mm.

21. The capacitive touch panel of claim 19 or 20, further comprising a rear face facing display screen and made of sapphire material where the rear face of sapphire material has been ion bombarded by using an ion beam wherein the ions are chosen from the ions of the atoms from the list consisting of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), silicon (Si), phosphorus (P) and sulphur (S).

22. The capacitive touch panel of claim 21 wherein the rear face of sapphire material has a thickness less than or equal to 400 µm, for example equal to 100 µm.

23. The capacitive touch panel of claim 21 or of claim 22 wherein the front face, the capacitive detection layer and the rear face are jointly assembled and separated from the display screen by an air layer.

24. The capacitive touch panel of any of claims 19 to 23, wherein at least a lateral side of at least one face made of sapphire material has been ion bombarded by using an ion beam wherein the ions are chosen from the ions of the atoms from the list consisting of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), silicon (Si), phosphorus (P) and sulphur (S).

25. The capacitive touch panel of any of claims 19 to 24, wherein the light transmission of the light emitted by the display screen, as for example measured at a 560 nm wavelength, is greater than or equal to 90%, for example equal or greater to 97%, even more equal or greater to 98%.