CLAIMS

1. A method for depositing AlN on a silicon substrate having a crystallographic direction of <111> and being arranged in a process chamber, the method comprising:

arranging an aluminum target in said process chamber;

providing a process gas composition comprising a noble gas and nitrogen to said process chamber;

ionizing said process gas composition by providing an electric field and a magnetic field such that a getter of noble gas ions and nitrogen ions is formed;

sputtering said aluminum target while applying a positive bias on the silicon substrate; and

depositing an epilayer of aluminum and nitrogen on the silicon substrate.

2. The method according to claim 1, wherein the process gas composition, when provided to said process chamber, has a total pressure of less than 2 mTorr.

3. The method according to claim 1, wherein the silicon substrate and the aluminum target are substantially parallel and arranged at a distance in a range from and including 1 cm to and including 10 cm from each other.

4. The method according to claim 1, wherein the positive bias is applied as a DC bias, the bias voltage of the DC bias in the range of 1 kV to 5kV, a power of the DC bias is in the range of 900 to 1500 W, and the DC bias is pulsed with a frequency in a range from and including 10 kHz to and including 350 kHz.

5. The method according to claim 1, wherein a total pressure in the process chamber during sputtering is less than 7.5 mTorr (1 Pa).

6. The method according to claim 1, further comprising sputtering said silicon substrate by said noble gas before sputtering said aluminum target.

7. The method according to claim 6, wherein a time between sputtering said silicon substrate and depositing an epilayer of aluminum and nitrogen on the silicon substrate is less than 20 minutes.

8. The method according to claim 1, further comprising wet etching said silicon substrate in HF prior to said silicon substrate being arranged in said process chamber.

9. The method according to claim 8, wherein a time between wet etching said silicon substrate and depositing an epilayer of aluminum and nitrogen on the silicon substrate is less than 20 minutes.

10. The method according to claim 1, wherein said aluminum target is coaxial to said silicon substrate.

11. The method according to claim 1, wherein the process gas composition comprises argon, and wherein a ratio of nitrogen to argon is in the range of 1:1 to 1:3.

12. The method according to claim 1, wherein the process gas composition comprises argon, and wherein a partial pressure of nitrogen is in the range of 0.2 to 0.3 mTorr and a partial pressure of argon is in the range of 0.1 mTorr to 3 mTorr.

13. The method according to claim 1, further comprising heating the substrate to a temperature in the range of 600 to 1200 °C.

14. A gallium nitride semiconductor transition layer structure, comprising:

a silicon substrate having a crystallographic direction of <111>; and

a polycrystalline epilayer of aluminum and nitrogen disposed on and above said silicon substrate, said epilayer being obtained by a method according to claim 1;

wherein said polycrystalline AlN epilayer comprises a pillar nanostructure having an epitaxial relationship to said substrate.

15. The gallium nitride semiconductor transition layer structure according to claim 14, wherein said epilayer of aluminum and nitrogen comprises a first 3C-AlN epilayer of a thickness less than 5 nm in direct contact with said silicon substrate, and a 2H-AlN epilayer with a thickness in the range of 100 - 500 nm in direct contact with said 3C-AlN epilayer.

16. The gallium nitride semiconductor transition layer structure according to claim 14, wherein said pillar nanostructure has a thickness in the range of 10 - 60 nm.

17. The method according to claim 1, wherein, by applying the positive bias on the silicon substrate, the glow discharge, and therefore the getter of noble gas ions and nitrogen ions, is displaced towards the silicon substrate, thus, aluminum ions and nitrogen ions are attracted to the silicon substrate, and the getter of aluminum ions and nitrogen ions will be deposited on the silicon substrate, further attracting sputtered aluminum and ionized nitrogen, and hereby, the growth of an epilayer of AlN on the silicon substrate is promoted.