PECULIARITIES OF SAPPHIRE NITRIDATION UNDER THE INFLUENCE OF A HIGH-ENERGY ELECTRON BEAM

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Nitridation of the sapphire is the most important step in the growth of the III-nitrides on the sapphire. This process involves exposing a substrate to a flow of ammonia at elevated temperature. Nitridation of the reconstructed surface of the sapphire enriched by aluminum atoms is of special interest, since the presence of metallic bonds on the surface improves the quality of the structure.

The nitridation process during ammonia molecular beam epitaxy (MBE) has been studied using reflection high-energy electron diffraction as the reflex of the AlN crystalline phase appears near the reflex of the sapphire. The experimental results were processed in a special program, which measured the intensity of the most informative reflexes. Then, we plotted the dependence of the intensity of appeared reflexes of the AlN crystalline phase on time in the form of kinetic curves. During processing the experimental results of nitridation on the reconstructed surface of the sapphire it has been found that high-energy electrons have an impact on the process.

By heating the samples through heat radiation from the heater, the reconstruction of the surface (1x1) is observed. Then the sample is heated to the temperature of 1150 °C and the surface of the sapphire (1x1) starts to change to $(\sqrt{31} \times \sqrt{31})$ R±9° reconstruction. It is characterized by the sapphire surface depletion of oxygen and aluminum enrichment. However, in our previous work it is shown that there is only a partial recovery of aluminum to the metal state [1].

We have found out that the surface reconstruction of sapphire (1x1) is nitridized for 10 minutes in a 25 sccm ammonia flow, whereas the surface with the reconstruction of $(\sqrt{31} \times \sqrt{31})$ R±9° is not nitridized and the AlN crystalline phase is not formed. It has been noted that under the influence of fast electrons with the energy of 11 keV, the irradiated section of the $(\sqrt{31} \times \sqrt{31})$ R±9° reconstructed surface is destroyed within 10 minutes, the

surface of the sapphire is restored to its original state with the reconstruction (1x1), and then it is successfully nitridized.

To investigate the effect of a high-energy electron beam on the nitridation process, experiments were conducted to destroy the $(\sqrt{31} \times \sqrt{31})$ R±9° reconstruction to (1x1) at different temperatures (750 °C, 825 °C, 900 °C). The duration of the impact and the intensity of the electron beam varied. The influence of the pulse width depending on the pulse ratio to the kinetics of nitridation of the sapphire was studied: in the first case, the momentum of an electron beam was continuous; in the second case the relative pulse duration was S = 2, and in the third one it was S = 20. So we could restore the nitridation kinetics in the absence of exposure to electrons. It has been shown that through eliminating the influence of the electron beam the process of forming the AlN crystalline phase goes on appreciably slower and is different from the process in a continuous exposure in k = 6 times. In case of low intensity the nitridation process also slows down. Using the obtained kinetic curves of the nitridation process has made it possible to investigate the influence of the degree of completion of the process of nitridation on the further growth of the AlN buffer layer.

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REFERENCE

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