Formation of cone-shaped and crystallographically oriented defects at the Cz-Si wafer surface using the helium implantation and DC nitrogen plasma treatment

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In our previous work [1] we investigated the possibility to form the buried insulating Si₅N₃ layers by a new method based on the nitrogen gettering onto buried defect layer created by helium pre-implantation. One of the problems of this method is the formation of surface defects when the number of implantation-induced defects in the buried layer does not correspond to the number of introduced from plasma nitrogen atoms. The goal of this work is more detailed study of near-surface defects formed.

Standard 4.5 Ω×cm phosphorus doped Cz Si wafers were subjected to helium ion pre-implantation at room temperature with the energy of 300 keV and the fluences of 1×10¹⁵, 5×10¹⁵, 1×10¹⁶ or 2×10¹⁶ at/cm². Then the nitrogen was introduced into wafer from a DC plasma source at the temperature of 350 °C. Finally, we subjected all the samples to vacuum annealing at 800 °C. The structural properties of the formed samples were studied by scanning electron microscopy.

The experiments have shown that the crystallographically oriented and cone-shaped defects are formed at the surface of the treated silicon wafer. The typical length of crystallographically oriented line defects equals to 1-2 mm. Base diameter of cone-shaped defects is equal to 200-2000nm, the aspect ratio is appr. 1:1. The X-ray microanalysis of cone-like defects does not reveal any chemical elements except silicon and nitrogen. Such defects have enhanced emission ability in comparison with the nontreated silicon surface. Increase of helium implantation fluence leads to decrease of defects number.


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