(Amorphous Carbon)-(Diamond) Electronic Microstructures Made by Fine Focus Ion Implantation

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Two types of planar structures have been investigated (Fig. 1): (i) gap-structures composed of two adjacent highly implanted (above the amorphization dose of diamond; typical doses > 10^{15} cm^{-2}) contact squares separated by low (below swelling threshold dose of diamond; doses < 10^{14} cm^{-2}) implanted gaps of a few micrometer length, and (ii) line-structures composed of two highly implanted contact squares connected by highly implanted stripes of a width 0.1 to 10 µm and length 10 to 50 µm. 100 keV Ga^+ and 200 keV Dy^{2+} Ions were used for the implantation.

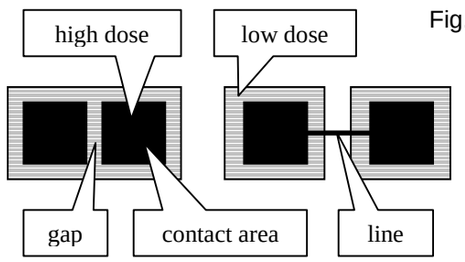
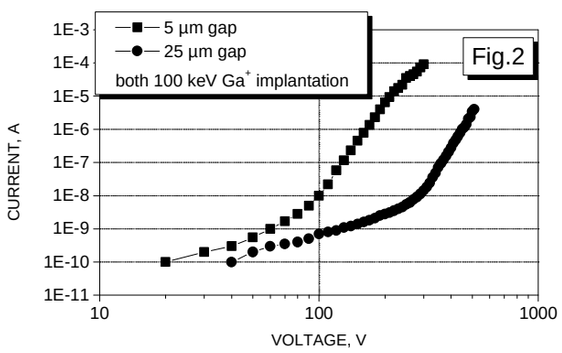


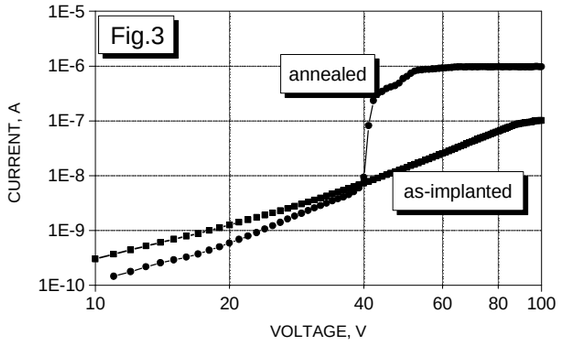
Fig.1

The main results of the research are:

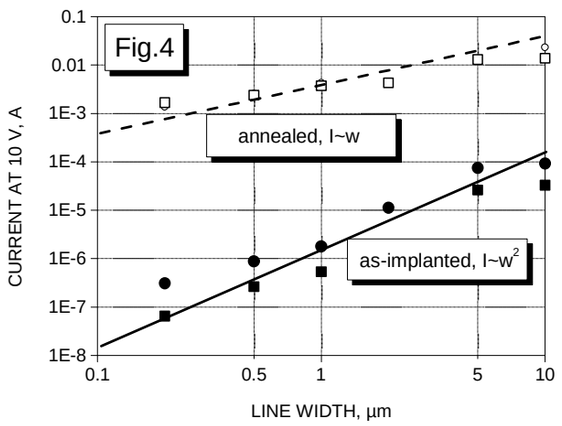
(i) Non-linear (exponential, power or their combination) current-voltage characteristics of the gap-structures (Fig. 2) and relatively high currents in them are interpreted in terms of electron injection from amorphized contact areas into insulating diamond over a 0.3 eV height barrier [1].



(ii) Enhancement of conductivity of the gap-structures implanted with Dy^{2+} ions after annealing at 1300°C (Fig. 3) (in contrast to strong reduction of the conductivity in the annealed Ga^+ implanted structures) is explained as an electrical activity of Dy impurity in diamond.



(iii) Superlinear dependence of conductivity of the line-structures on the line width in the as-implanted state transforms into the liner dependence after annealing at 1300°C (Fig. 4). The explanations of the effect are given in terms of hopping conductivity in the as-implanted lines (possible concentration of the hopping electrons about 10^{15} cm^{-3}) and squeezing of the conductive channels due to depletion of the amorphous carbon by the electrical potential built on the heterojunction (amorphous carbon)-(diamond) [2]. The conductivity of the annealed stripes is believed to be graphite-like with the mobile electron concentration of 10^{20} cm^{-3}.



Possible applications of FIB technique for fabrication of micro-optical devices (diffraction gratings and Fresnel lenses) on diamond are discussed.

[1] I. A. Dobrinets, A. M. Zaitsev, T. Etzel, J. Butler, A. D. Wieck. *J. Wide Bandgap Materials*, 9 (2001) 7.

[2] N. A. Poklonsky, S. A. Vyrko. *Izvestia VUZ: Physics*, BGU, Minsk, No 10 (2002) 70 (in Russian).