STUDY of Zn IMPLANTED SiO_2 FILMS for MEMRISTOR APPLICATION

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Introduction

The properties of metal and its oxide nanoparticles (NPs) in semiconductor and dielectric matrixes are widely investigated because of such material possible application in modern microelectronics devices. Zinc oxide NPs plays an prominent part, since ZnO has wide direct-band gap of 3.37eV and large exiton binding energy of 60meV. So they can use in various optoelectronic devices. Due to other ZnO unique properties, they are use in in solar cells, gas sensors , spintronic and memory devices (memristors), in medicine and biology. There are several attempts to form Zn and ZnO NPs in silica glass by Zn implantation and thermal oxidation. Here we present the results of NPs formation in $^{64}Zn^{+}$ ion implanted SiO2 film for memristor application.

Samples

Au (bottom electrode) with thickness of 64nm and SiO2 film 150nm thick were successively deposited onto quartz substrates by electron-beam evaporation. Then Zn was implanted with a dose of 3×1016/cm2 and an energy of 40keV. The ion current density was less than 0.5μA/cm^2, so the target heating as compared with the room temperature didn't exceed the 50^{o}C Then these structures were oxidized in air for 40 min at temperatures of 400-800˚ C with a step of 100˚ C. The upper electrode was made of deposited Al.

To study the surface the scanning electron microscopy (SEM) was used in combination with energy-dispersive spectroscopy (EDS). To study the Zn profiles during annealing, Rutherford backscattering spectroscopy (RBS) was used. The surface topology and of surface potential of Zn implanted sample was determined by AFM technique. The created phases were identified by photoluminescence (PL) at 10K. The current-voltage characteristics (CVC) of the obtained structures were studied.

SEM study of as implanted samples

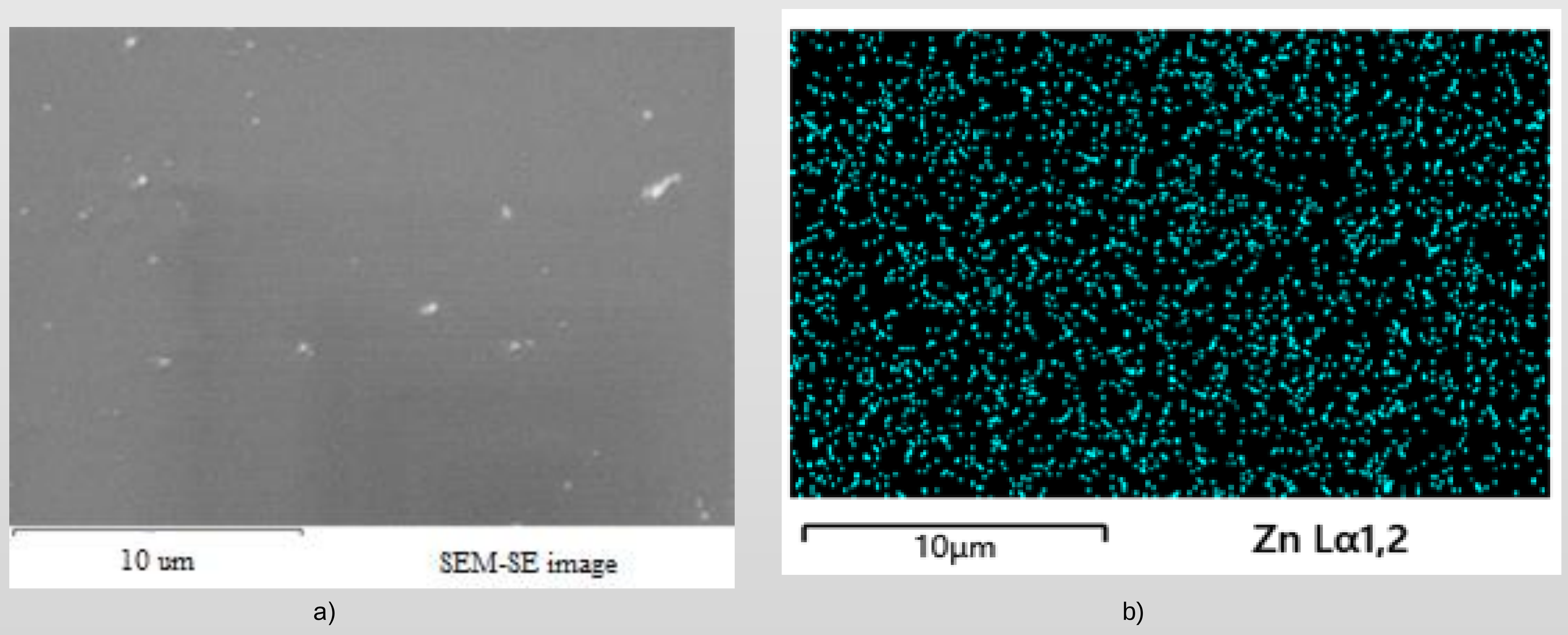


Fig.1. SEM-SE (a) and EDS image of Zn Lα1,2 line for as implanted sample.

SEM and EDS images of annealed samples

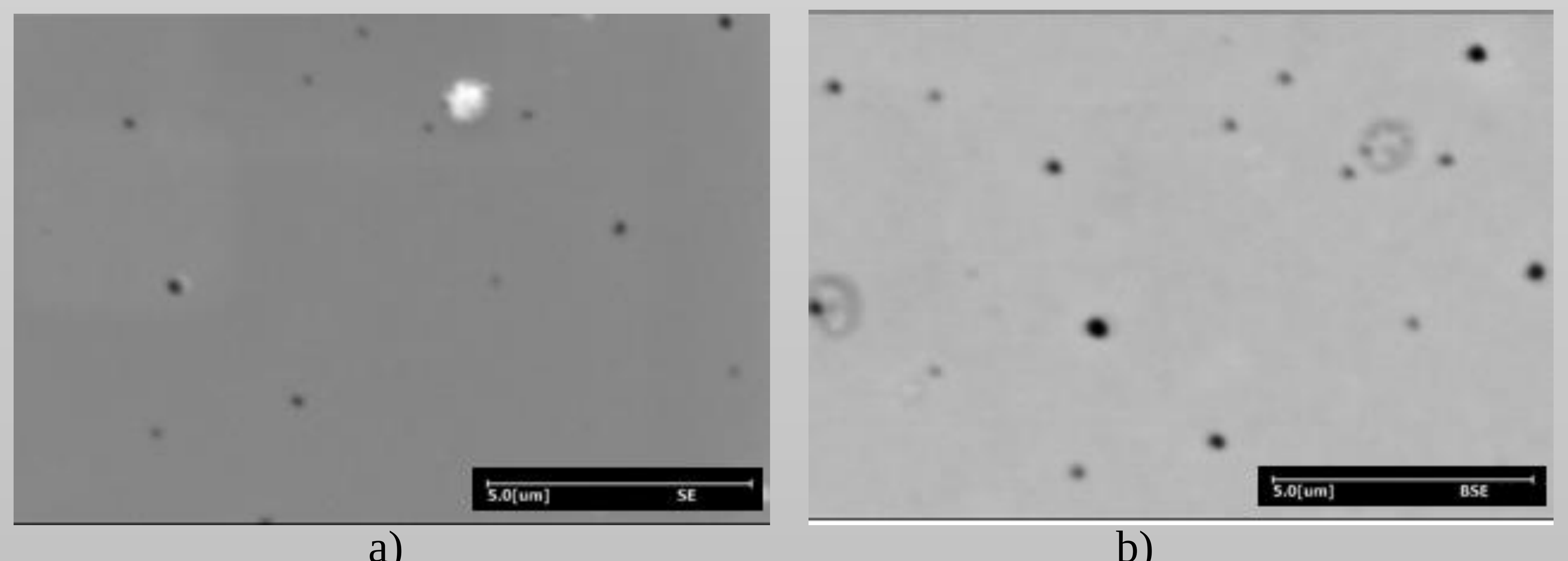


Fig.2. SEM-SE(a) and SEM-BSE (b) images for annealed sample.

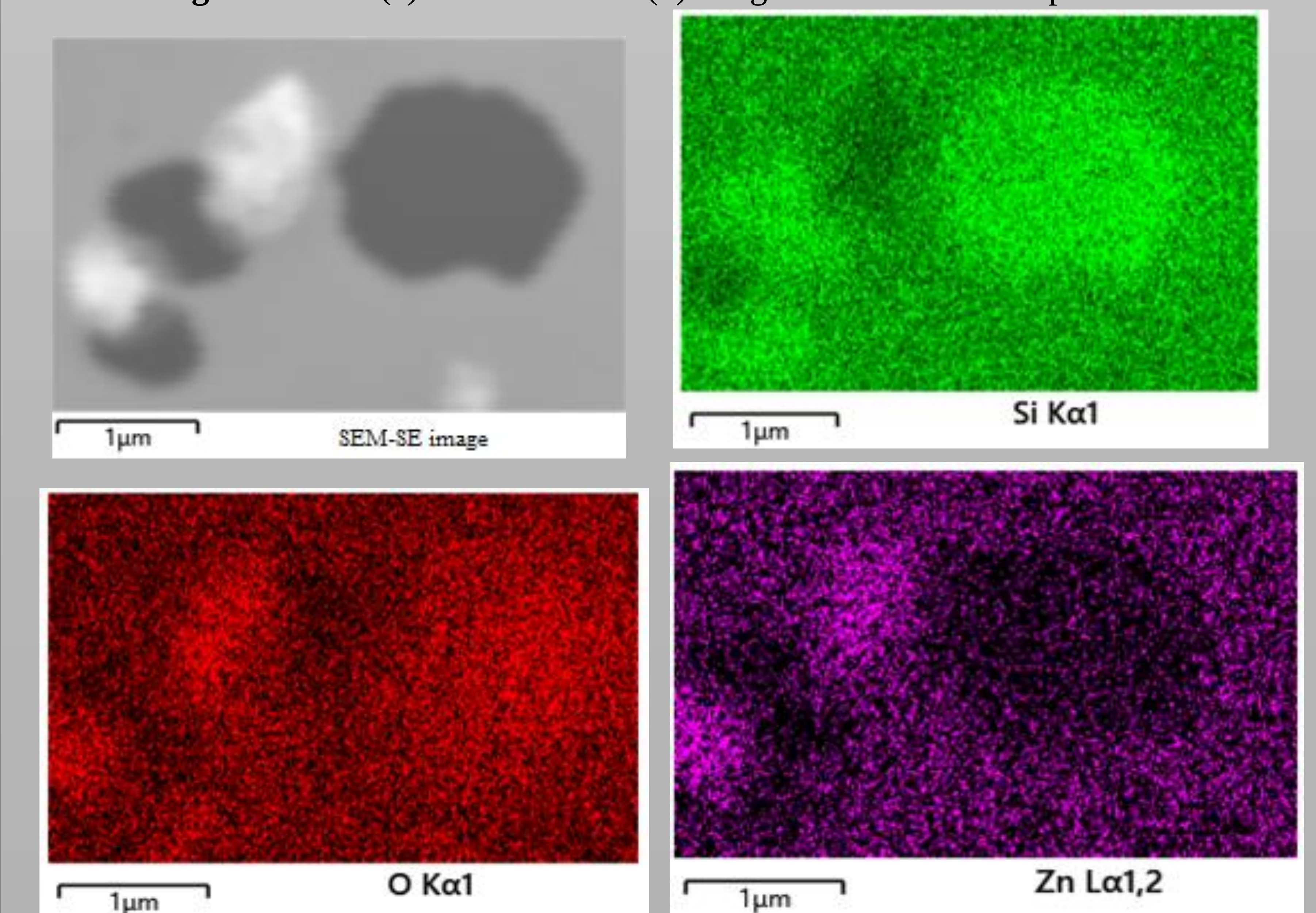


Fig.3. SEM-EDS images for annealed sample.

RBS study

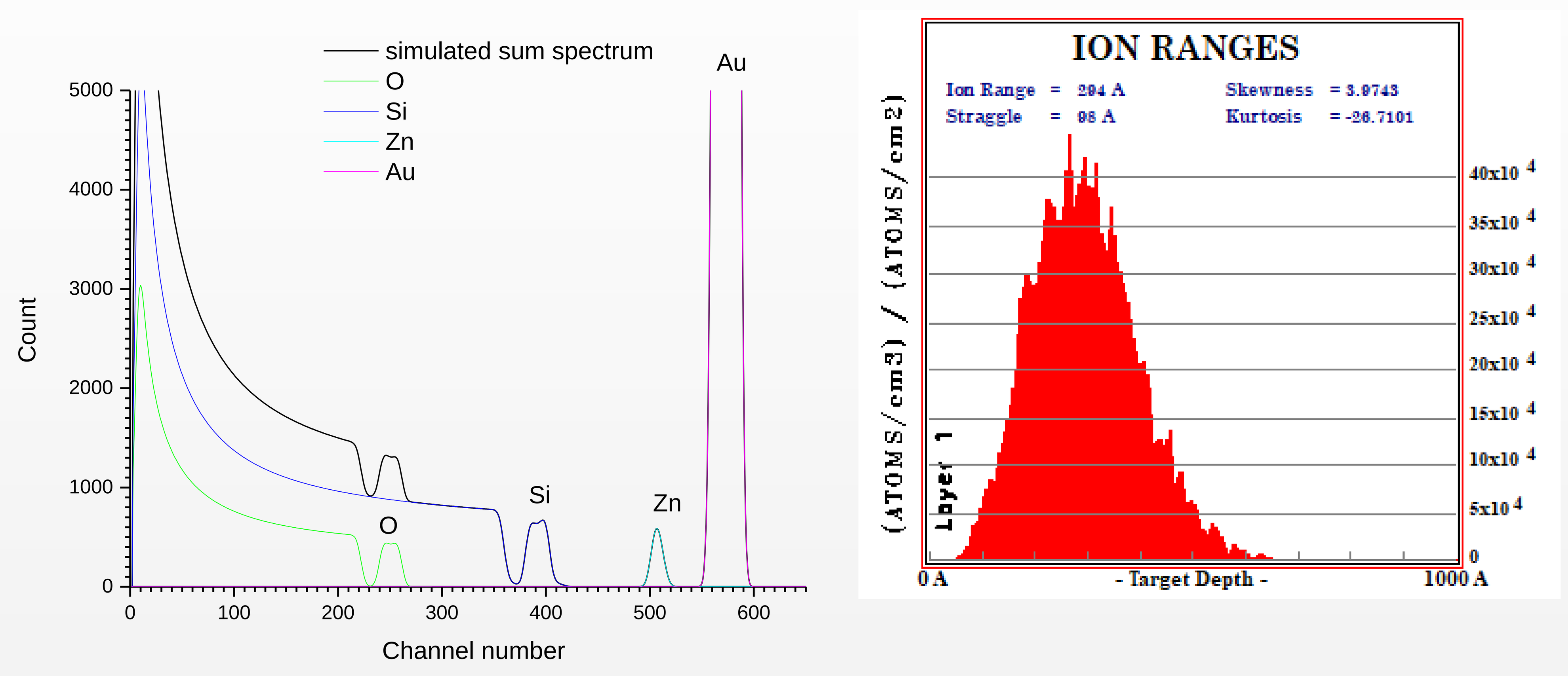


Fig.4. Survey TEM image (a) and corresponded EDS concentration profiles of SiKα1 (b), ZnKα1 and OKα1 of a subsurface Si layer.

RBS experimental spectra

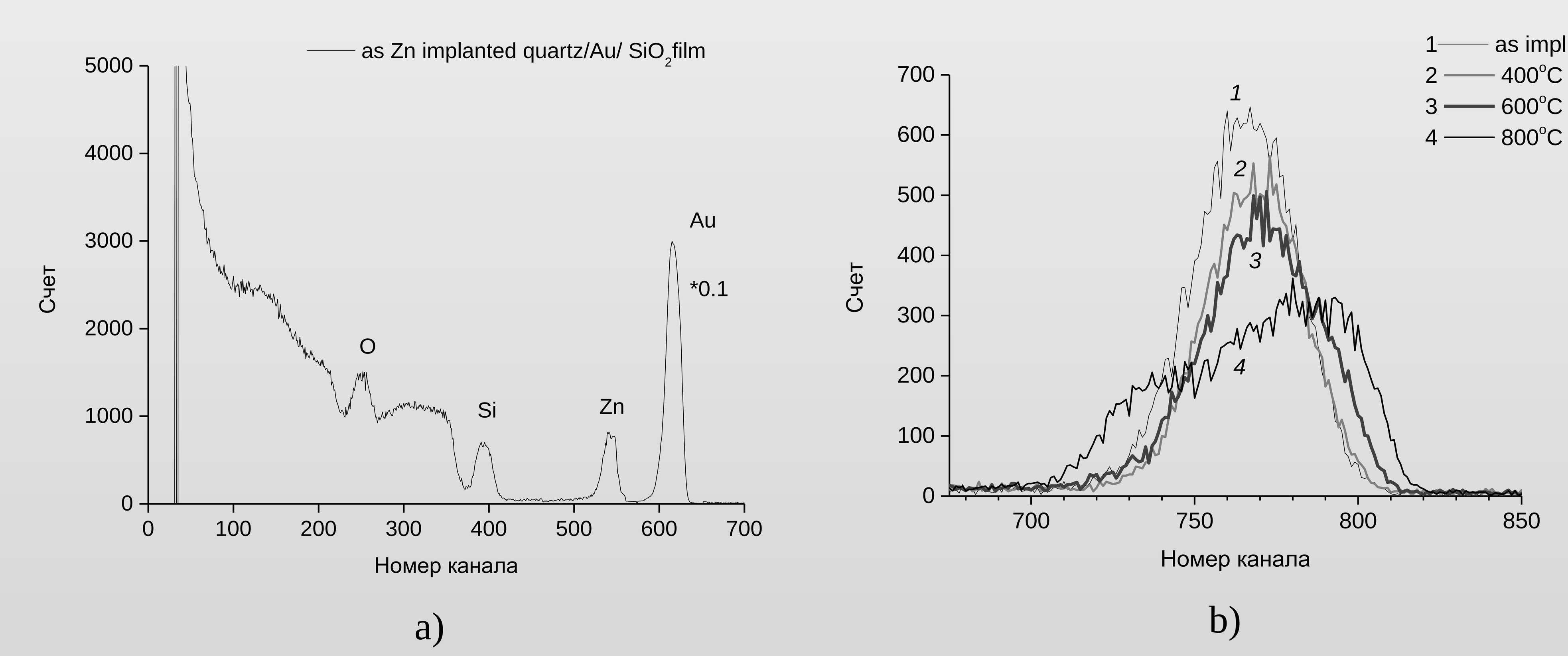
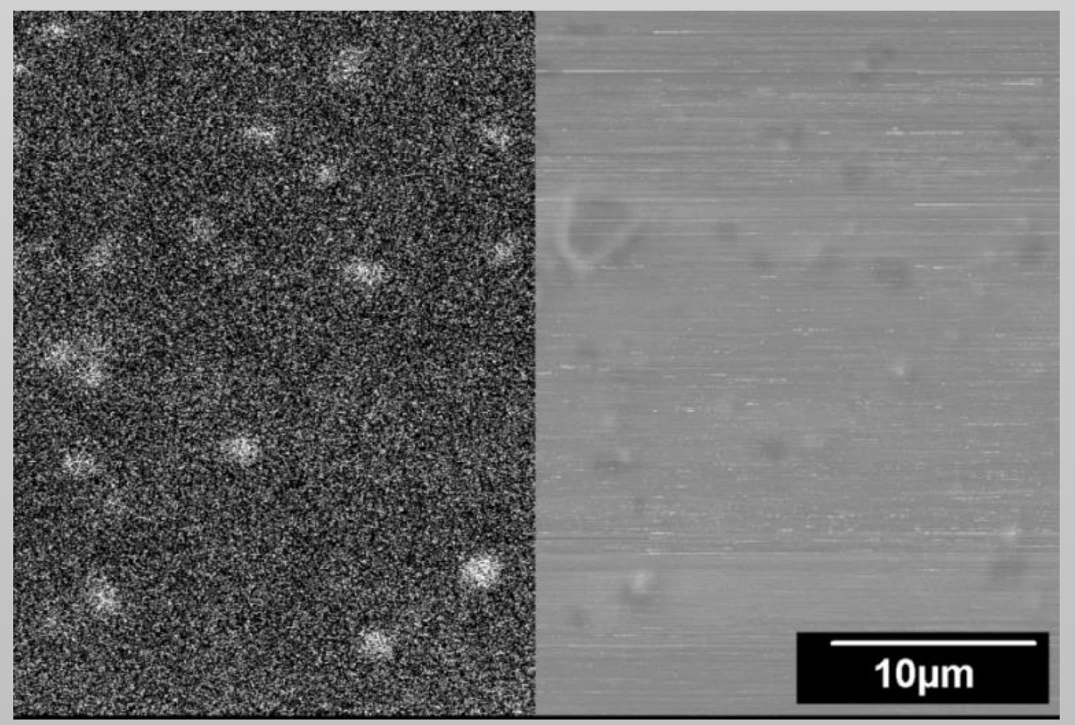


Fig.5. Experimental RBS spectra of as implanted sample (a) and annealed sample for Zn zone (b).

Cathodoluminescence studies of annealed samples



a) b)

Fig.6. Cathodoluminescence image of annealed sample (a) and corresponded SEM-SE image (b).

Photoluminescence and current –voltage characteristic

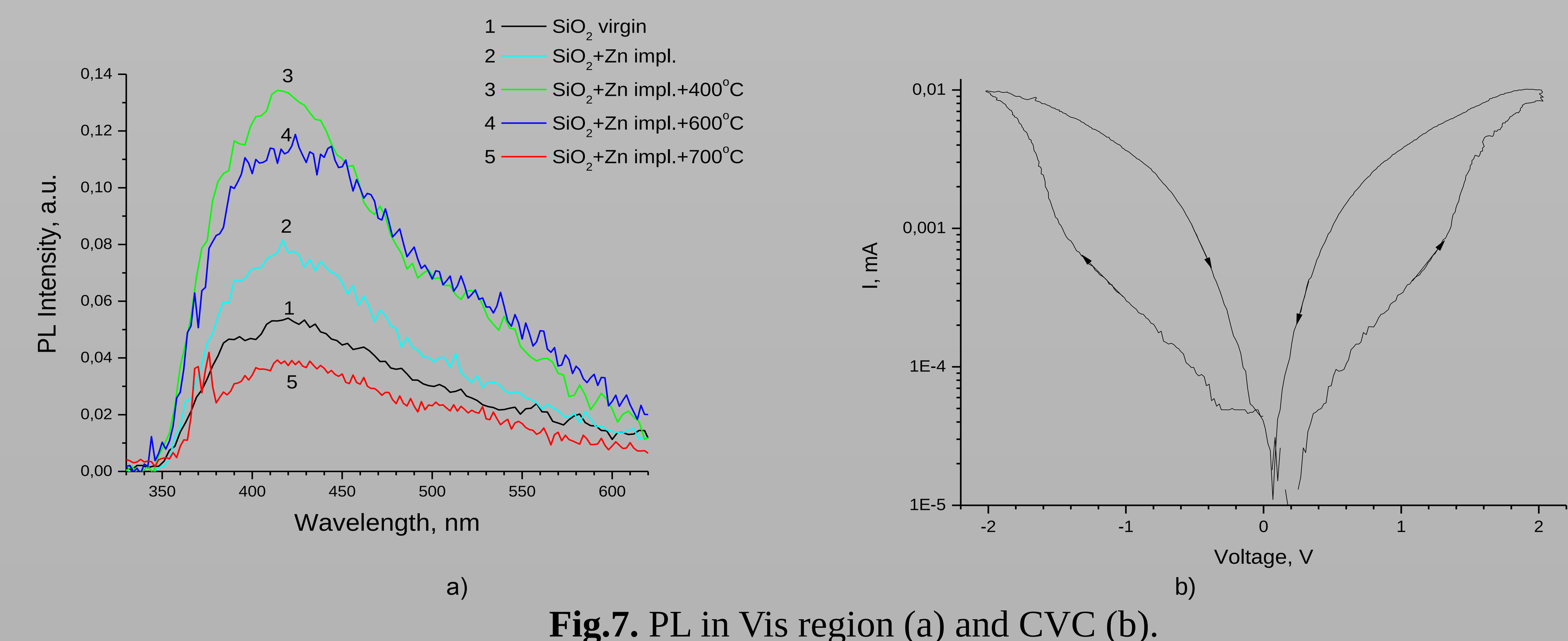


Fig.7. PL in Vis region (a) and CVC (b).

Conclusions

1) After implantation the Zn atom concentration maximums are at a depth of 40nm due to SRIM calculation.
2) After implantation on a sample surface and in subsurface layer the NPs of order 100nm.
3) After annealing NPs are presented presumably in Zn or ZnO phase.