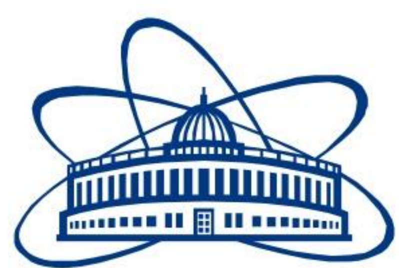


Investigations of chemical composition and thickness of oxide layers deposited on SI GaAs implanted with Xe ions

P.L. Tuan[1,2,*], M. Kulik[2,3], J. Nowicka-Scheibe[4,2], J. Żuk[3], P. Horodek[2,5], L.H. Khiem[6,7], T.V. Phuc[2,6,7], Nguyen Ngoc Anh[8], M. Turek[3],

[1] Hanoi Irradiation Center, Vietnam Atomic Energy Institute, Hanoi, Vietnam

[2] Joint Institute for Nuclear Research, Dubna 141980, Russia

[3] Institute of Physics, Maria Curie-Skłodowska University, Pl. Marii Curie-Skłodowskiej 1, 20-031 Lublin, Poland

[4] Department of Organic and Physical Chemistry, Faculty of Chemical Technology and Engineering, West Pomeranian University of Technology Szczecin, Piastów Ave. 42, 71-065 Szczecin, Poland

[5] Institute of Nuclear Physics, Polish Academy of Science, Krakow 31-342, Poland

[6] Institute of Physics, Vietnam Academy of Science and Technology, 10 Dao Tan, Ba Dinh, Hanoi, Vietnam

[7] Graduate University for Science and Technology, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam

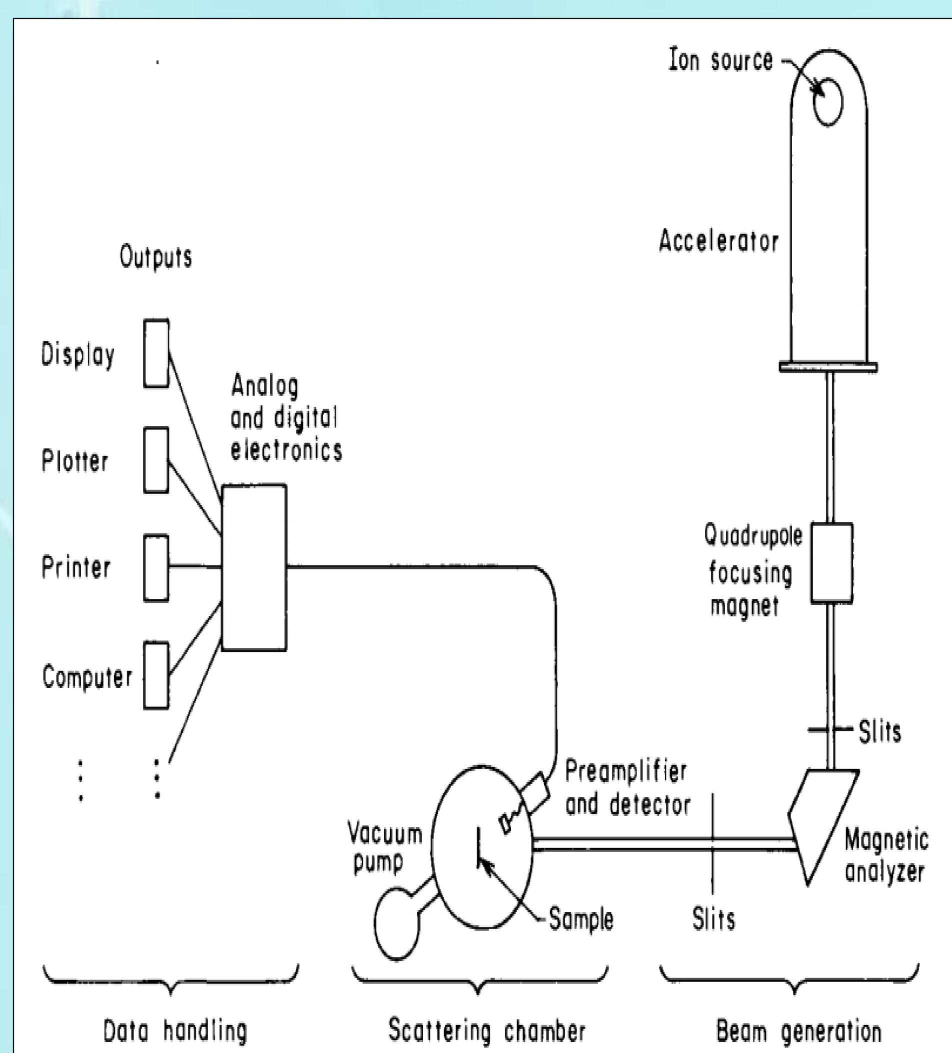
[8] Institute of Research and Development, Duy Tan University, Danang 550000, Vietnam

INTRODUCTION

- **Surfaces of (100) SI GaAs irradiated with 250 keV Xe^+ beam at room temperature. The implantation doses for individual sample varied from 1×10^{12} cm^{-2} to 3×10^{16} cm^{-2}.**
- **The characterization of native oxide layers and their thicknesses were performed using the nuclear reaction (NR) method.**
- **The depth profiles of As, Ga and Xe atoms were measured by the Rutherford backscattering spectrometry (RBS).**
- **The chemical composition of studied oxides layers was determined by the X-ray photoelectron spectroscopy (XPS) technique.**

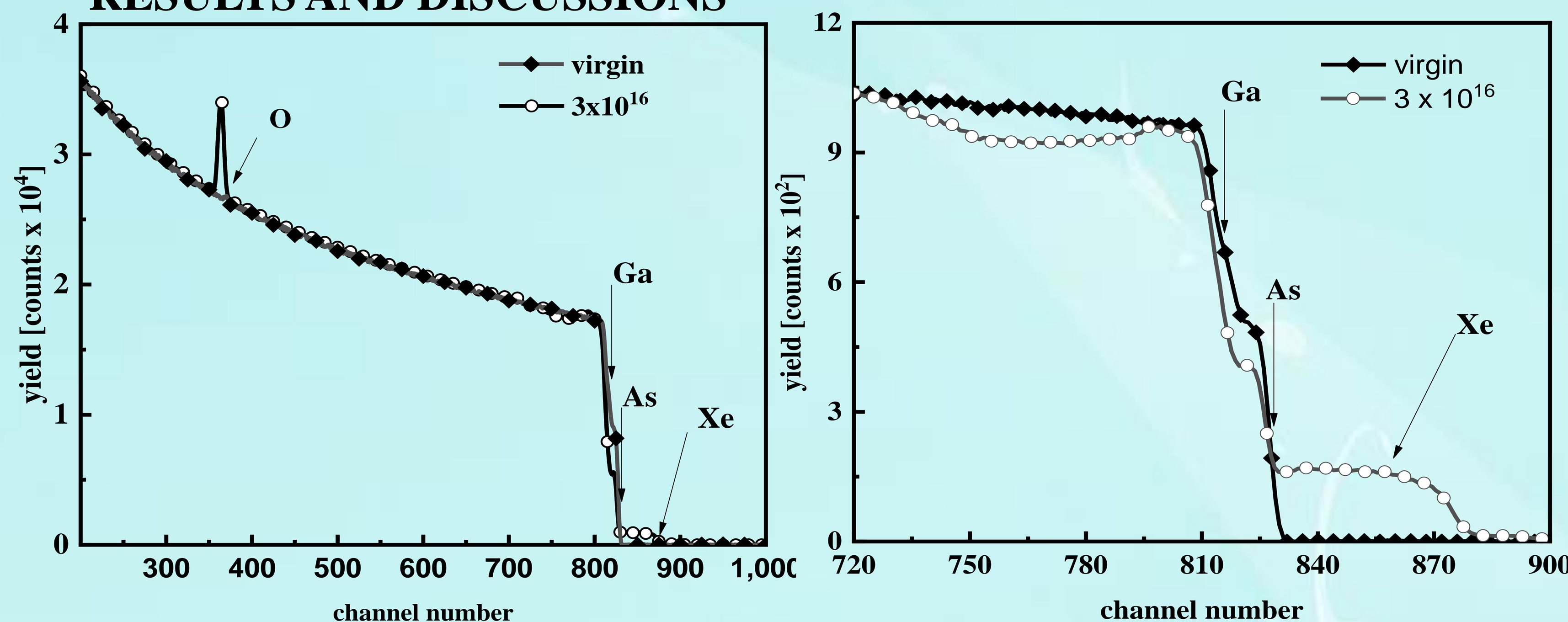
EXPERIMENTAL

- **The GaAs samples were implanted with Xe^+ ions. The process was performed at room temperature with the use of a UNIMAS implanter.**
- **The surface atomic concentrations of the near surface layers of GaAs samples were investigated by RBS/NR method at JINR, Dubna.**



- **The chemical compositions of the near surface layers and native oxide layers were analyzed by the XPS method using the spectrometer equipped with the monochromatized AlK$_\alpha$ radiation.**

RESULTS AND DISCUSSIONS

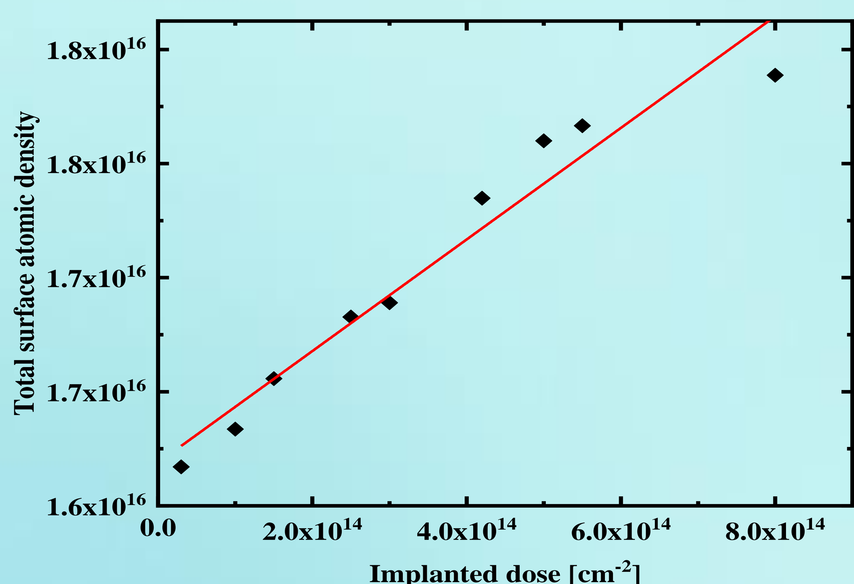


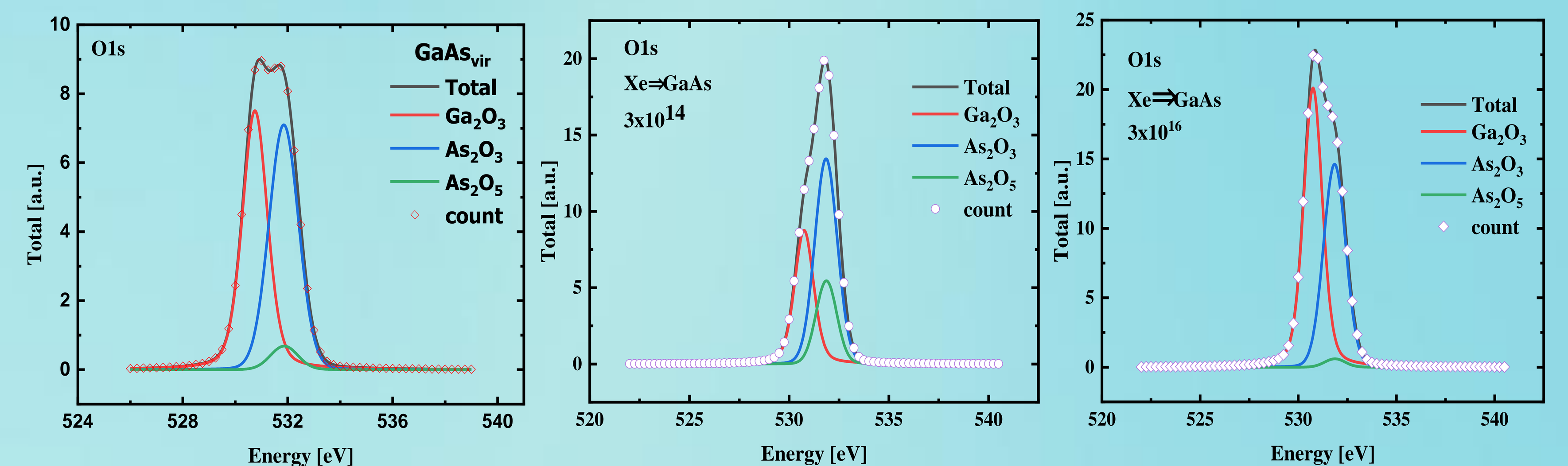
The two typical spectra of scattered α particles on the nucleons of the atom located in the near surface layers in virgin and implanted GaAs with Xe^+ ions.

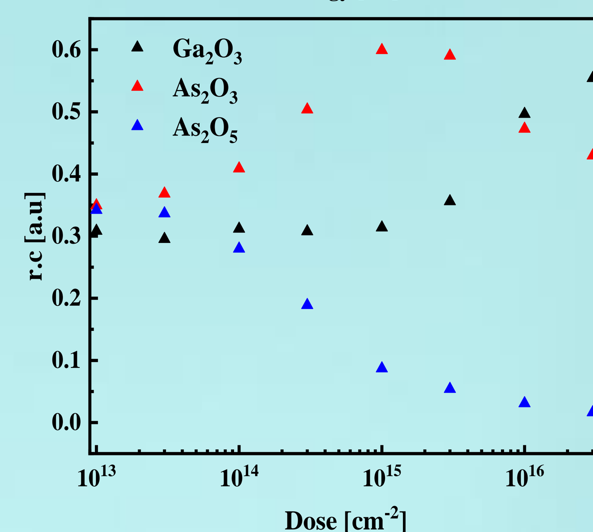
The RBS/NR spectra were registered for all studies samples. All samples were measurements under the same conditions.

In there measurements the nuclear resonance reaction was applied. The intensity of the band close to the energy value 1.1 MeV can confirm that the layers enriched with oxygen atoms conversed the surfaces of virgin and implanted GaAs.

Based on RBS measurements the atomic surface densities of the other elements in the near surface layers were made.

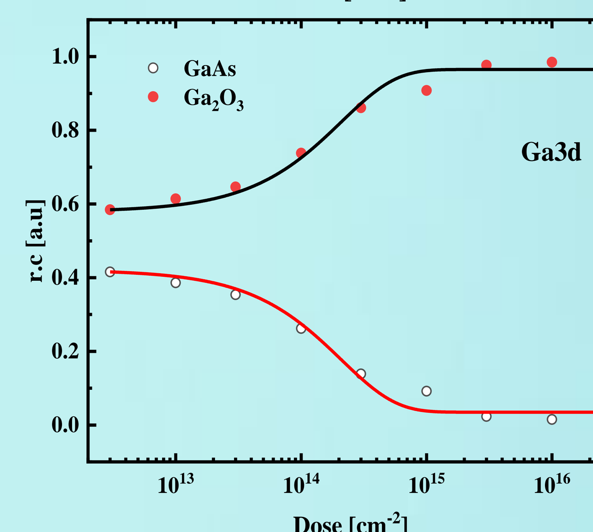


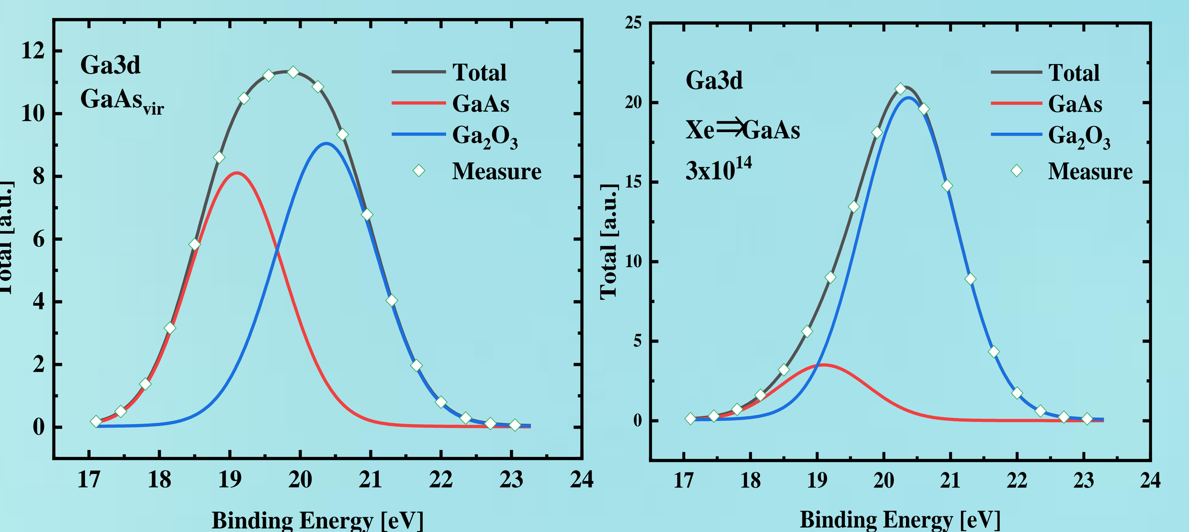




The shapes of these spectra differ for the GaAs samples after implanted Xe^+ ions, because of the change of concentration of the compounds Ga_2O_3, As_2O_3 and As_2O_5

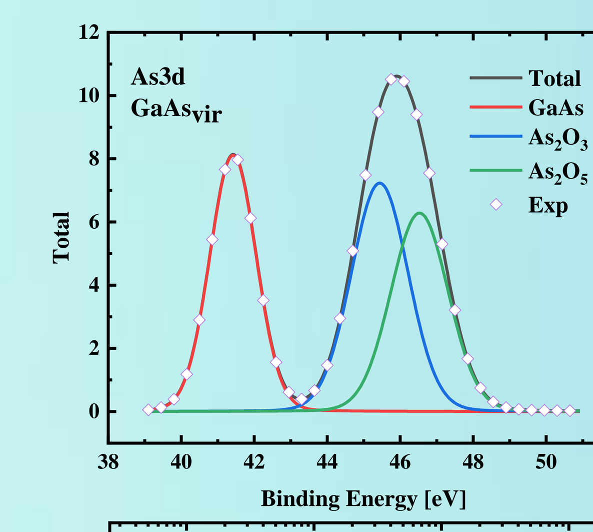
From there spectra can see change of relative concentration of each compound reaches for the implantation fluencies higher than 4×10^{15} cm^{-2}

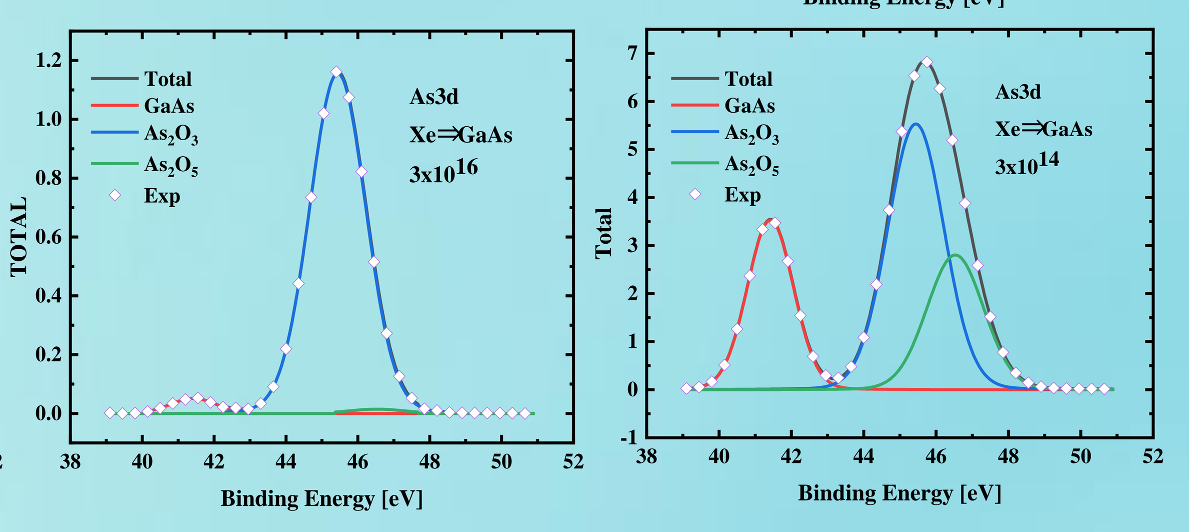




The spectrum shape is changed after ions irradiation. From the obtained results were fitted for the relative concentration of Ga_2O_3 and GaAs.

The quantity of Ga_2O_3 increases and that of GaAs decreases with the increases fluence of ion implantation





There spectra show that concentration of As_2O_3, As_2O_5 and GaAs in the native oxide layers covering the surface implanted are different.

The concentration of As_2O_5 is lower than of As_2O_3 because of the decrease in the concentration of arsenic compounds in the process implanted ions in samples.

CONCLUSIONS

- **The thickness of oxide layer is large for implanted GaAs than for the unimplanted samples**
- **The surface concentration of oxygen is a linear function of the implanted dose in the range from 3×10^{13} cm^{-2} to 8×10^{14} cm^{-2}.**
- **These results indicate increasing of Ga_2O_3 in comparison to As_2O_3.**
- **The amount of As_2O_5 in the oxidized region decreases with applied dose.**

REFERENCES

[1] M. Kulik, W. Rzodkiewic, L.Gluba, A.P. Kobzev, Dielectric function of native oxide on ion implanted GaAs, Acta Phys0. Pol. A 123 (2013) 956.

[2] J.R Cameron, Elastic scattering of alfa-particles by oxygen, Phys. Rev. 90 (1953) 839

[3] W.K. Chu, J.W. Mayer, M.A. Nicolet, Backscattering Spectroscopy, Academic Press, New York San Francisco London, 1978