сообщения
объединенного
института
ядерных
исследований
дубна

E14-89-512

B.Słowiński, R.Wiśniewski

TEMPERATURE AND PRESSURE INVESTIGATION OF HIGH ENERGY Ar AND Xe IMPLANTED MANGANIN

1989

1. INTRODUCTION

It is well known that manganin (alloy of Cu and 2.5-3.5% of Ni, and 11-13.5% of Mn) is widely used as convenient pressure sensor in the middle and high range of pressure, i.e. above 100 MPa, by reason of its linear pressure dependence of the resistance R, as well as weak temperature (T) dependence of R (see, for instance,[1]). Nevertheless, the temperature coefficient of resistance, (dR/dT)/R, is sufficiently small, i.e. it reaches its plateau, within narrow interval of temperature only. This plateau is of great practical interest too, because of some shift of temperature coordinate of extreme point of resistance of the alloy under pressure. Therefore, different attempts should be undertaken to extend the plateau. Certain possibility in the way provides high dose and high energy ion implantation.

The purpose of the work is to study how significant the change of electro-thermocharacteristics of thin foil of manganin may occur when irradiated in the beams of ions of $^{40}_{18}Ar$ at the kinetic energy of 46 MeV (i.e. 1.15 MeV/amu), and ions of $^{136}_{54}Xe$ at 118 MeV (0.87 MeV/amu). Although there isn´t any relative theoretical predictions, some hints based on general physical considerations may be drawn indicating a suitableness of such investigations.

II. MATERIAL

Narrow sheets of foil of the manganin flatten to the thickness of about 12 μm have been used to investigate a possible change of the alloy after ion implantation. Their plate dimentions were: 2.5-3 mm and 10-15 mm.

III. IMPLANTATION

Manganin slices were implanted with either Ar or Xe ions at the cyclotron U-300 of the Laboratory of Nuclear Reactions at the Joint Institute for Nuclear Research, Dubna. Ion doses

Table

Ion	Kinetic energy (MeV)	Average projected range (μm)	RMS projected range (μm)
Ar	46	5,93	0,25
Xe	118	7,77	0,34

were $3\cdot10^{13}$ cm^{-2} in the case of Ar at the ion current $5\cdot10^{9}$ cm^{-2} s^{-1}, and $2.5\cdot10^{14}$ cm^{-2} in the case of Xe at the ion current $4\cdot10^{10}$ cm^{-2} s^{-1}. The slices were implanted at 30^{o}C owing to permanent water cooling during the implantation. So, main characteristics of implanted mass profiles calculated using EDEP 85/88 computer program are given in the table.

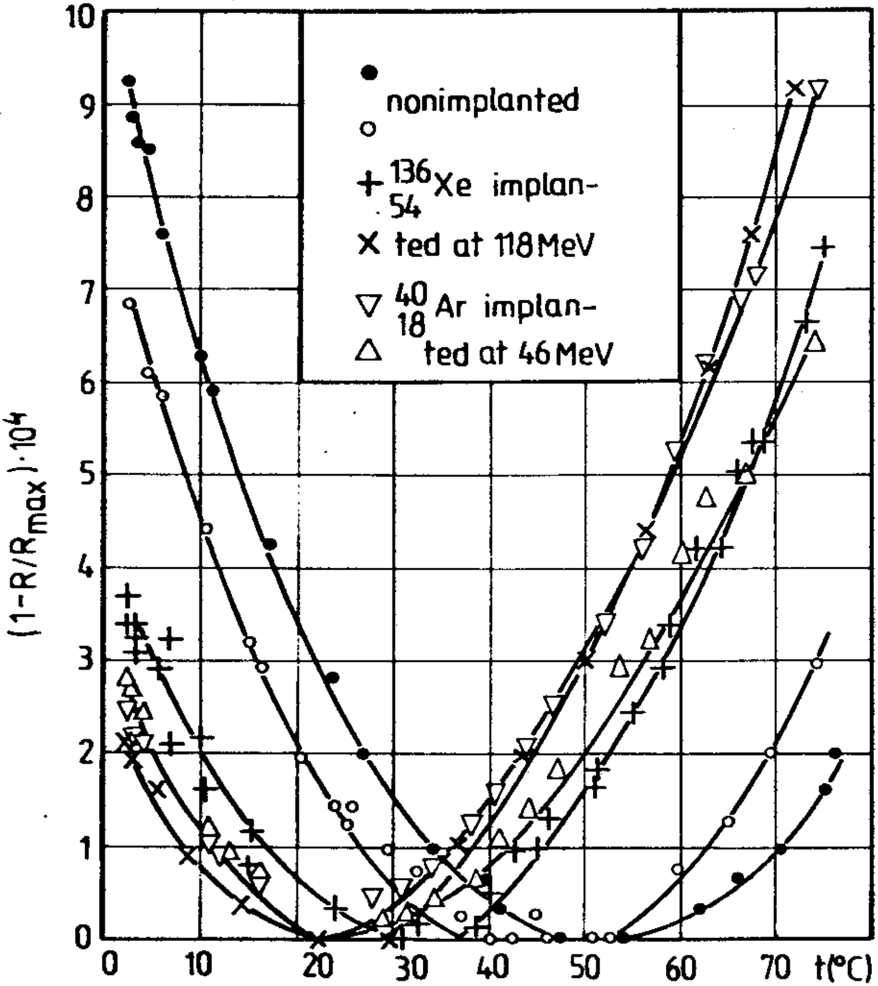
IV. TEMPERATURE AND PRESSURE MEASUREMENTS

The temperature dependence of the value $(1-R/R_{max})$ for prepared manganin specimens has been studied in the range 3^{o}C to 75^{o}C. Here R_{max} is the maximum value of the resistance R. The results are shown in the Figure for argon and xenon implanted manganin, as well as for the sample non-implanted, in two of each specimen, to check a possible influence of the method. The measurements have been carried out by means of common four-probes method.

One can notice that temperature behaviour of the ratio R/R_{max} is approximately parabolic within investigated range of temperature. The maximum of this dependence is markedly shifted for implanted slices in comparison with non-implanted ones toward lower values of temperature by about $\Delta t=25^{o}$C.

Furthermore all slices were studied under pressure in the range 100 MPa to 600 MPa at the temperature of 22^{o}C, using common high pressure apparatus /1/. So, the ratio $\eta = (\Delta R_{im}/R_{im})/(\Delta R_{ni}/R_{ni})$ was determined, where R_{im} and R_{ni} are resistances of implanted and nonimplanted samples, correspondingly, and ΔR_{im} and ΔR_{ni} are their relevant changes.

It is worth to stress that average value of the ratio η is equal to 1.04 ± 0.01 for xenon implanted manganin and 1.02 ± 0.01 for argon implanted manganin. So, data are showing rather a tendency to increase η only.



Temperature dependence of the relative resistance for implanted and nonimplanted manganin slices.

V. CONCLUSIONS

Summarizing our results one can draw some conclusions. The first and perhaps the most interesting one concerns the significant shift (Δt = 25°C) of temperature dependence of the resistance noticed in the case of implanted manganin slices. Moreover, parabolic shape of this dependence does not change within the experimental errors. Secondly, pressure change of the relative resistance has turned out, on the average, very small being rather a sign of possible change at higher doses and/or at any other kind of implanted ions.

As the temperature t_{min}, at which $(1 - R/R_{max})$ reaches its minimal value is anomaly high for implanted (and flatten) manganin slices, one can suppose that aforesaid temperature shift may be caused by implantation as playing a part of seasoning too, and so removing intrinsic mechanical tension. To explain this problem all slices have been submitted to heat treatment in motor oil at 170°C during 200 hours, and then temperature measurements have been repeated again. Unfortunately, the obtained results don´t allow us to draw any definite conclusion in the question.

Finally, it seems to be reasonable to suggest a supposition that the manganin implantation using Mn, Ni and Cu as dopant ions instead of ions of inactive elements (Ar, Xe) would exert a desirable influence on characteristics we have studied. Such ions, being of the same kind as the atoms of irradiated foil may produce in the material metastable heterogeneous states each having different properties[2]. So, an extension of the plateau of the temperature coefficient of manganin resistance would be possible.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation to Dr. A.Yu.Didyk for his kind help in performing of the manganin implantation at the cyclotron U-300 of the JINR (Dubna).

REFERENCES

1. Wiśniewski R. et al. - High Pressures. Warsaw, 1980 (in Polish).
2. Poate J.M. - In: Intern. Conf. on Ion Beam Modification of Materials. Budapest, Hungary, 4-8 September 1978, p.1797.

Received by Publishing Department
on July 5, 1989.