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DEEP ION IMPLANTATION INTO MANGANIN TO MODIFY ITS PRESSURE AND ELECTROTHERMOCHARACTERISTICS

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1. INTRODUCTION

Numerous experimental works have been performed by then using energetic ion beams for the modification of different properties of thin films. As a result, various interesting and useful changes of their characteristics were found out; consequently an increasing number of experimental investigations in the field is in progress now. Indeed, ion energy and intensity, ion species, angle of incidence as well as accompanying ambient conditions may be chosen and controlled independently from each other making that ion implantation has turned out to be one of the most flexible and promissing method of treating materials.

In our previous work [1] we have reported on the significant shift (of about 25°C) of temperature dependence of the resistance of manganin thin slices when irradiated with both Ar and Xe ions at about 1 MeV/u to doses $3 \cdot 10^{13}$ cm^{-2} and $2.5 \cdot 10^{14}$ cm^{-2}, respectively, as compared to the nonimplanted ones.

It is worth mentioning that manganin is commonly recognized to be the best sensitive to pressure resistance alloy and, therefore, is widely used as a conveient pressure gauge within the intermediate and high range of pressure owing to the linear pressure dependence of its resistance as well as weak enough temperature dependence of this resistance (see, for example, [2]). Moreover, it is cheap and has some further advantages over the other resistance alloys, such as zeranin and the Au-Cr alloy. Nevertheless, because of too narrow plateau of the temperature coefficient of resistance some shift of the temperature during an experiment may cause an increase both in systematic and/or statistical error of the measured value of pressure which could be sometimes difficult to evaluate reliably enough. To diminish the shortcoming different attempts have been undertaken. Our approach is to use to this purpose the ion implantation technique which can efficiently affect the electrical resistivity of thin metal and metalic alloy films.

2. MODEL

As it follows from recent experimental works the electrical resistivity of a material is a consequence of phase changes which may occur, for example, during ion irradiation [3] or may be simply a result of the local concentration of implanted ions. Besides, in the case of ceramic materials this characteristic strongly depends on heterovalence substituting admixtures introduced by means of ion implantation and suitable thermoprocessing of the material [4]. Accordingly, using high energy ion implantation technique it is possible, in principle, to create within a primary slice of manganin some multilayer or sandwich has its temperature dependence of the relative resistance, shifted in comparison with the other ones with the result that the slice as a whole has the temperature plateau much broader than previously. Because the manganin properties under discussion slightly depend on the concrete comparison of this alloy (typically: 2.5—3.5% of Ni, 11—13.5% of Mn and Cu) such system could be produced first of all when manganin slices are exposed in turn to the beam of ions like their own components, viz. Cu, Ni and Mn, and having different energies. Taking into account that the thickness of commonly used manganin sheet is about 12 μm the beam energy should range from about 0.4 MeV/u to 1.2 MeV/u, the thickness of each implanted layer being then within the interval of 0.2—0.4 μm, evaluated using the EDEP 85/88 computer program as the RMS projected range. Our first results have proved that a fluence of $3\cdot10^{13}$ cm^{-2} and $2.5\cdot10^{14}$ cm^{-2} is enough to cause some appreciable effect.

Another approach is to create such dynamic system in which, under pressure and at the temperature changing, some part of electric charge carriers is squeezing out into the conduction band while approximately the same their part is falling down to the valence band, so that the total current through the slice holds practically constant. Unfortunately, at present it is not clear how such a system could be created in practice and the only way that seems to remain is to experiment.

3. CONCLUSION

Basing on our previously obtained experimental results concerning the noticeable shift of the temperature dependence of the relative esistance of manganin irradiated with both 46 MeV Ar and 118 MeV Xe to doses $3\cdot10^{13}$ cm^{-2} and $2.3\cdot10^{14}$ cm^{-2}, respectively, we have suggested two ways how to enlarge the plateau of this dependence and thus making the manganin to be more universal and reliable pressure sensor. The first or static way consists in the creation of the multilayer or sandwich system when each layer has its own narrow plateau a little shifted with respect to other ones, so that the plateau of the whole system is much broader. The second or dynamic way comes to the formation of such a system when any change of the resistance could be selfcompensating one.

REFERENCES

1. Słowiński B., Wiśniewski R. — JINR, E14-89-512, Dbna, 1989.
2. Wisniewski R. et al. — High Pressures. Warsaw, 1890 (in Polish).
3. Alford T.L. et al. — Nucl. Instr. and Meth., 1991, B59/60, p.401.
4. Anushkova N.V. et al. — Short Communications on Physics (Russian), No.2, 1991, 7.

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Висьневски Р., Словински Б. E14-92-178
Глубокая ионная имплантация в манганин
с целью модификации его электротермохарактеристик

На основании имеющихся экспериментальных данных по внедрению высокоэнергетических ионов Ar и Xe (~ 1 МэВ/е.м.) в манганин выдвинуто предположение о двух возможных способах улучшения электротермохарактеристик манганина, находящегося в условиях высокого давления. Первый способ состоит в создании многослойной структуры с результирующим плато температурной зависимости относительного сопротивления, значительно более широким, чем до имплантации. Второй способ сводится к образованию некоторой самокомпенсирующейся системы на основе манганина.

Работа выполнена в Лаборатории высоких энергий ОИЯИ и в Институте физики Варшавского технологического университета.

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Deep Ion Implantation into Manganin
to Modify its Pressure and Electro-Thermocharacteristics

On the grounds of previously obtained experimental data concerning the high energy (~ 1 MeV/u) Ar and Xe ions implantation into manganin, two suggestions to create the manganin based systems having improved pressure and electro-thermocharacteristics are put forward. The first way is to fabricate a multilayer system with the resultant plateau of the temperature dependence of the relative resistance much broader than the initial one. The second way comes to the formation of some manganin based selfcompensating structure.

The investigation has been performed at the Laboratory of High Energies, JINR and at the Institute of Physics, Warsaw University of Technology.

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