# INVESTIGATION OF THE ELEMENTAL STRUCTURE OF BERYLLIUM SURFACE AFTER SELF-SPUTTERING AT THE DIFFERENT ANGLES OF IRRADIATION

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Beryllium is being considered as plasma facing material for ITER-reactor. It is expected that the operation temperature range of the first wall and divertor is (670-1070)K. In the ITER divertor physical sputtering will be one of the factors limiting its lifetime. By Rutherford backscattering (RBS) method the elemental surface structure of beryllium after self-sputtering with ions of beryllium at energy 1 keV at different angles of irradiation was determined. A commercial hotpressed powder metallurgy products beryllium of TShP-type, containing o.9 wt.% of O, was used in experiments. Before irradiation the Be sample surfaces were mechanically polished with a diamond paste and then electrolytic polishing was used. A few samples of Be were used in experiments without polishing.

Fig. 1 shows the RBS spectra of the helium ions scattered at the angle of 160° upon as received beryllium and after Irradiation by 1 keV $Be^+$-ions at the incidence angles of 45° and of 70°. In the spectra of initial beryllium (fig. la) and that irradiated at the angle of 70° (fig. lb) the peaks of carbon and oxygen are present. The spectrum at the angle of 45° (sputtering yield is equal 0,7 at./ion) in fig. lc differs from two others by the presence of an intense broad peak extending directly beyond the peak of oxygen and overlapping the channel of carbon. As a result of beryllium sputtering by $Be^+$-ions carbon peak is reduced from 12 at.% in the initial sample to 5,5 at.% at angle of 45° and to 4 at.% at angle of 70° after bombardment. Meanwhile the irradiation by $Be^+$-ions results in the surface enrichment with oxygen and in an increase of a layer thickness containing the atoms of oxygen (fig.2). When the angle of incidence is equal 45°, along with the peak of oxygen on the surface, a second peak on the oxygen profile, including up to 25 at.% of oxygen at the peak is observed (fig.2a). The minimum in the oxygen depth distribution profile formatting in the process of irradiation is probably connected with radiationenhanced segregation of oxygen atoms to the surface. The production of a sublayer enriched with oxygen is provided by the fact that the self-sputtering yield of beryllium is less then unity (flg.3). This means that the amount of $Be^+$-ions incident upon the target is more than the number of sputtered Be-atoms, i.e. the Be-layer built up upon the target surface takes place. It is evident that the beryllium capture of oxygen atoms in this case. Fig.2b illustrates the depth distribution of oxygen in the beryllium irradiated by $Be^+$-ions at the angle of 70°, when the sputtering yield is equal 1,35 at./ion (fig.3) and the build up of the sublayer with two peaks does not occur.

The experimental self-sputtering yield of Be-TShP sample as a function of the angle of ion incidence for an ion energy of I keV at temperature 670K is shown in fig.3 [1]. The calculated curve Y-self-sputtering as function of angle and experimental data for Be self-sputtering from [2] are also shown in fig.3. The maximum value of experimental and calculated sputtering yield takes place at the same angle of incidence 75°. However, the calculated sputtering yield is by a factor of ~1,75 higher than experimental value.

Thus the experimental value of self-sputtering yield were obtained for surface, which is slightly enriched with oxygen atoms. Hence, the self-sputtering yield of beryllium is not influenced by a surface layer with such slight oxygen enrichment.

## REFERENCES

1. Guseva et.al., 12th International conference on plasma surface interactions in controlled fusion devices (20-24 May 1996, France). Book of abstracts.

2. Ehechtl, J.Roth, W.Eckstein. C.H.Wu, J. Nucl. Mater. 220-222 (1995) 883.

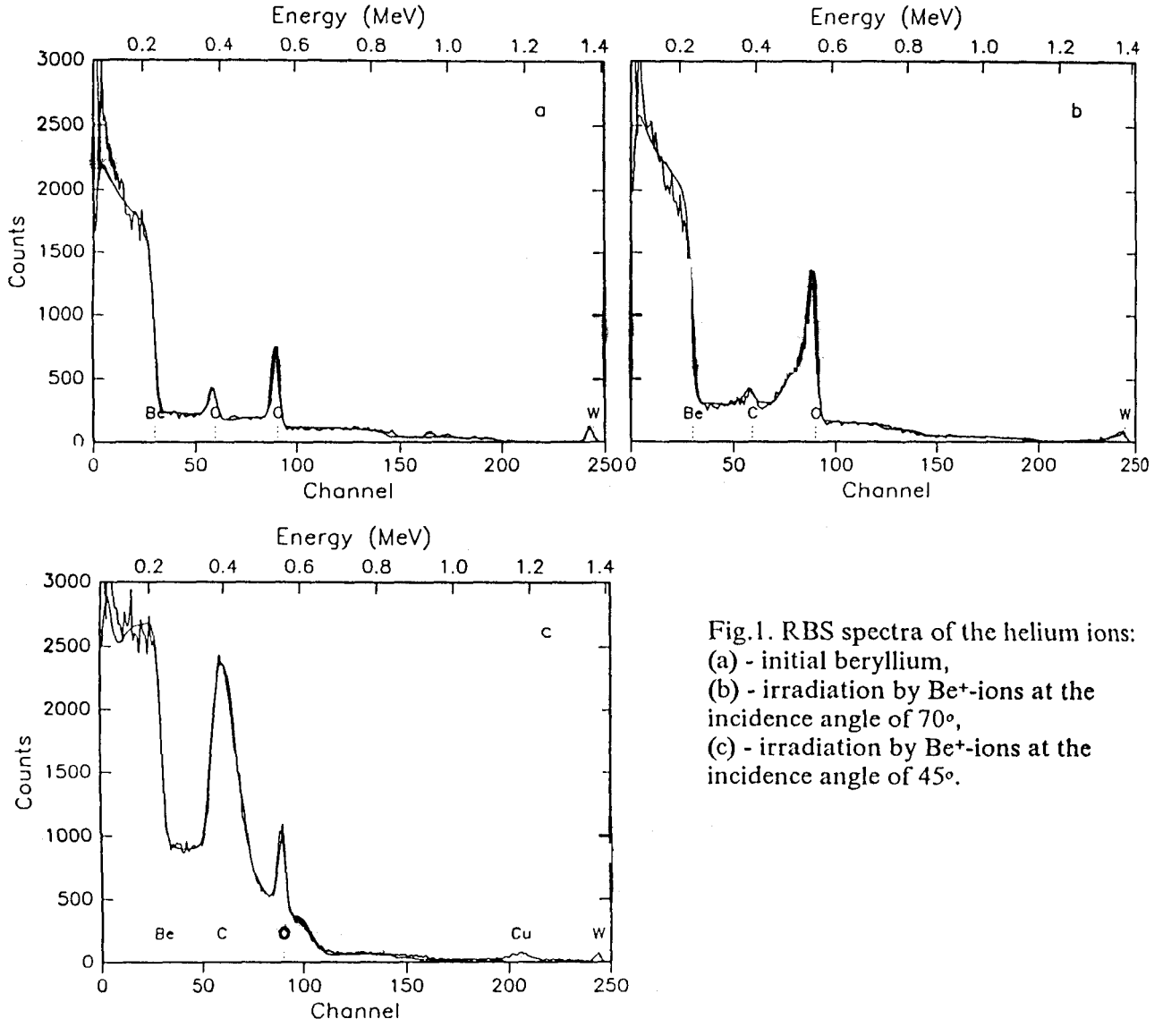


Fig.1. RBS spectra of the helium ions:
(a) - initial beryllium,
(b) - irradiation by $Be^+$-ions at the incidence angle of 70°,
(c) - irradiation by $Be^+$-ions at the incidence angle of 45°.

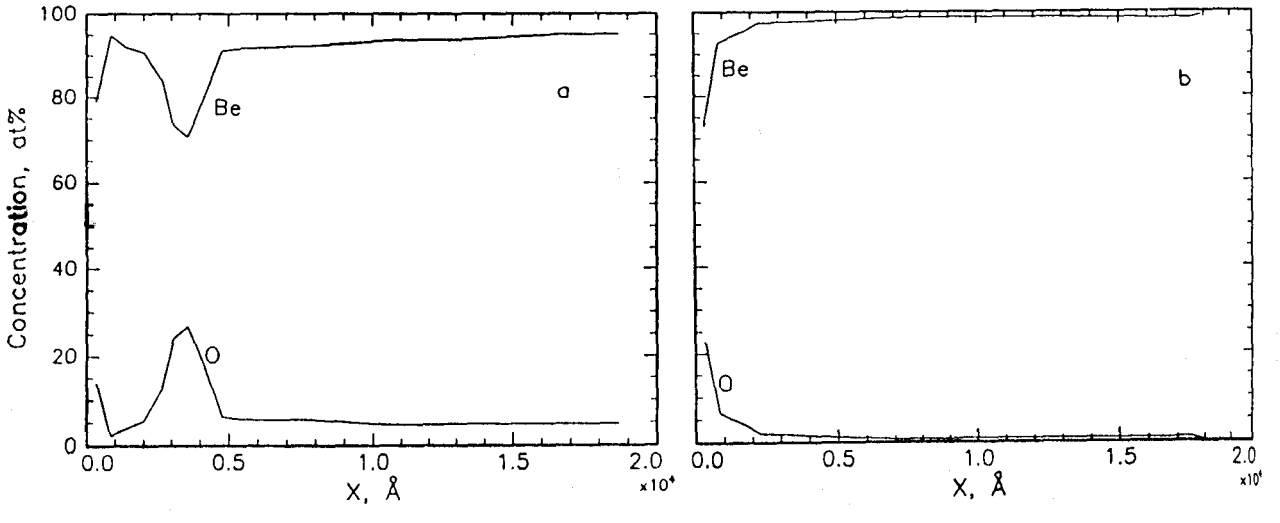


Fig.2. The profiles of oxigen and beryllium: (a) - incidence angle of 45°, (b) - incidence angle of 70°.

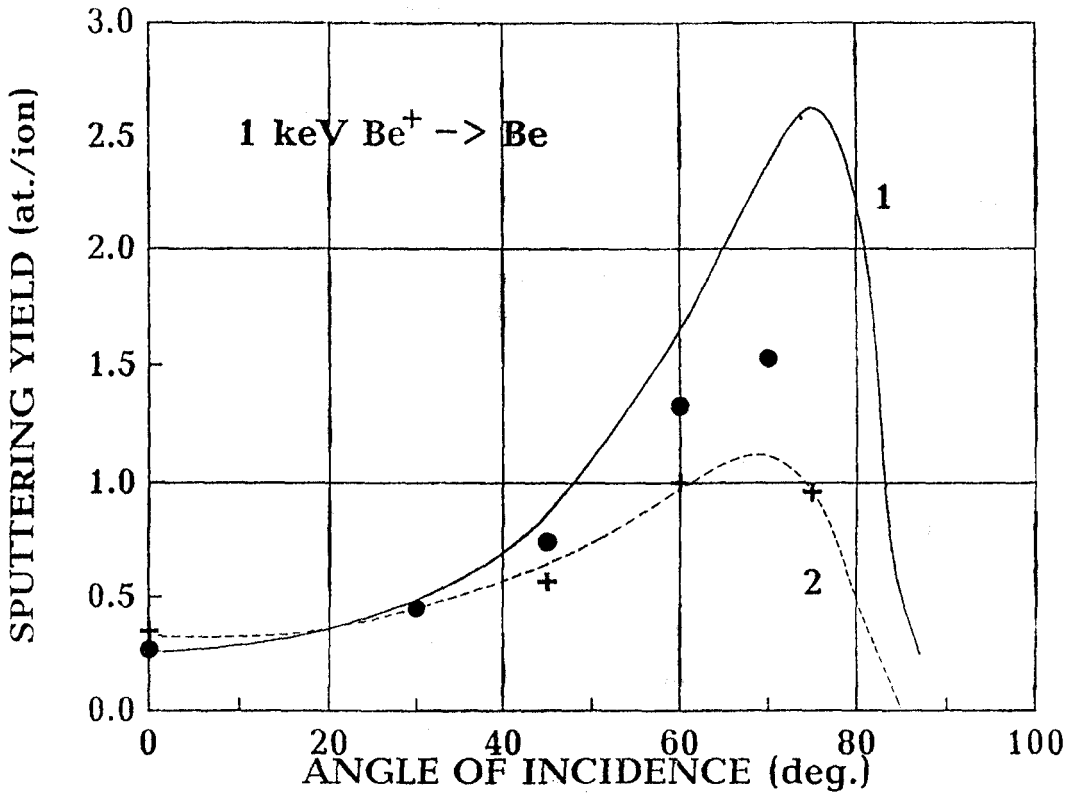


Fig.3. Self-sputtering yield of Be versus angle of ion incidence for 1 keV:
TRIM.SP calculated by W.Eckstein et.al. (curve 1);
(+++)-experimental data obtained by J.Roth et.al. (curve 2);
(• • •)-experimental points measured by M.Guseva et.al.