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SURFACE COMPOSITION OF Ni-Zr ALLOY
- A Novel Approach in ISS Quantification -

H.J.Kang[1], J.C.Lee[1], D.J.O'Connor[2] and R.J.MacDonald[2]

[1]Department of Physics, Chungbuk National University, Cheongju, 360-763, Korea.
[2]Department of Physics, University of Newcastle, N.S.W. 2308, Australia.

Ion Scattering Spectroscopy(ISS) has proved extreamly valuable in examining ion-induced composition changes of binary alloys because it is very sensitive in the outermost atomic layer. Nevertheless, in ISS quantification, some doubts has been arised because of ambiguities of neutralization of ion scattered off the surfaces. In this study a novel approach using survival probability calculated directly from the charge exchange parameter has been applied in ISS quantification of NiZr alloy.

From Iss spectra, the composition of the outermost atomic layer can be estimated using the equation

$$\frac{C_{Zr}}{C_{Ni}} = S\frac{I_{Zr}}{I_{Zr}} \qquad \text{---------- (1)}$$

$S = \left[\frac{\sigma_{Ni}}{\sigma_{Zr}}\right]\left[\frac{P_{Ni}}{P_{Zr}}\right]$ where I_{Ni}, I_{Zr} are the ISS yields of the elements Ni, Zr in the alloy and S is the relative sensitivity factor given by the ratio of the differential cross section(σ_i) and of survival probability(P_i). Here σ_i can be calculated using the interatomic potential but P_{Ni}/P_{Zr} can not be predicted with any certainty. Therefore it has been necessary for the sensitivity factors to be assessed from the ratio of spectra from pure standards for the two components, as in AES or XPS quantification. However, there are two important assumption with this method. One is that the neutralization probabilities of the elemental standard samples are the same as for the alloy. The other is that structure factor which includes shadowing and blocking effects in alloy are the same as for the pure standards.

To reduce the problems introduced by the above assumptions, in ISS quantification, a new approach has been adopted in which the sensitivity factors are obtained directly from the survival probability and differential cross section ratios. The survival probability P^+ of a scattered ion escaping the surface as ion is given by

$$P^+ = \exp(-V_c/V_\perp) \qquad \text{---------- (2)}$$

where $V_\perp$ is the perpendicular component of velocity of the ion and V_c is the charecteristic velocity for the interaction which is made up of a transition rate, and a screening length. The values of $V_c/V_\perp$ were measured for the Ni-Zr alloy and presented in Fig.1 as a function of the energy of the exiting Ar^+ ion, with the

value of V_c normalized to the exit velocity V_i. From the sensitivity factor and ISS spectra, the composition of the outermost atomic layer was assesed and the results are tabulated in table 1. All these results clearly suggest that the outermost atomic layer of NiZr alloy under Ar^+ ion bombardment tend to be Zr-rich.

Table 1. The measured composition of the outermost atomic layer of NiZr(50at.%) alloy using ISS following Ar^+ ion bombardment.

Energy (keV)	σ_{Ni}/σ_{Zr} (ZBL)	P_{Ni}/P_{Zr}	I_{Ni}/I_{Zr}	Zr (at.%)
2	0.61	0.44±0.05	0.076±0.003	78±3
4	0.59	0.42±0.04	0.084±0.003	75±3
6	0.58	0.35±0.02	0.077±0.001	73±3

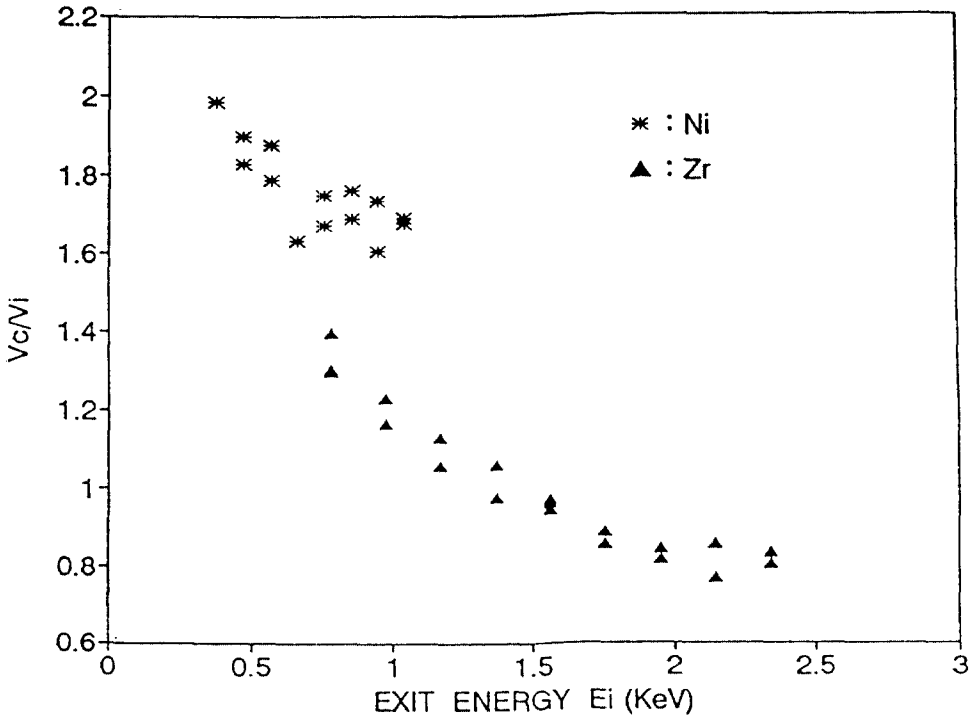

Fig.1. The value of characteristics velocity (V_c) normalized to the exit velocity (V_i) as a function of the energy of exit Ar^+ ion.