Axial Energy Analyzer: Ion Kinetic Energy and SIMS Spectrum from a CuBe Alloy

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The secondary ions from a CuBe alloy have been studied with a tandem ionizer /energy analyzer and quadrupole mass filter assembly. The addition of the energy analyzer makes it possible to collect the mass spectra for the secondary ions at various kinetic energies. These spectra demonstrate that the secondary ions produced by the impinging high energy primary ions have a wide range of kinetic energies and that different ions produced from the same surface can have very different energy distributions. gaseous molecules using Extrel C-50 quadrupole electronics.

I. INTRODUCTION

When a primary ion beam of up to 100 keV strikes the surface of a substrate, the secondary ions generated from the ion bombardment have a wide range of kinetic energies, which range from zero to the energy of the primary beam. The analysis of these secondary ions with a quadrupole mass filter thus requires an energy analyzer to remove the high energy ions, which travel too fast to be mass analyzed by the quadrupole mass filter. The addition of the energy analyzer also makes it possible to increase the sensitivities for some secondary ions from the alloy surface by collecting the spectrum at an optimized ion energy (in this case, the quadrupole will be floated to an appropriate potential to accommodate the change in the ion kinetic energy).

II. EXPERIMENTAL

The SIMS spectra for the CuBe alloy were collected using a tandem ionizer/energy analyzer with an ABB Extrel 3/4" quadrupole mass filter operating at 2.1 MHz. The experiments were carried out in a UHV chamber with a base pressure of 1.6x10-9 Torr. The primary ions were 2 keV Ar+ ions with an incident angle of about 80°. The collection angle (the angle between the sample surface normal and the axis of the SIMS probe) was about 10°. All of the SIMS spectra were acquired after the sample had been sputtered with a much higher current of the Ar+ ions. Thus, these SIMS spectra are characteristic of the unoxidized sample surface. In the experiments, ions of different kinetic energy were selected by the energy analyzer and the ions coming out of the energy analyzer were then mass analyzed by the quadrupole mass filter. The pass energy of the energy analyzer is set by the voltage applied to the main cylindrical lens of the energy analyzer (1) and the kinetic energy of the selected secondary ions is close to the pass energy.

III. RESULTS

The SIMS spectra collected at various pass energies are shown in Figures 1-4. The corresponding intensities of the Be+ and Cu+ ions are summarized in Table 1. The units for the ion intensities are kilocounts per second (KCPS).

Inspection of the mass spectra reveals the following characteristic of the secondary ions: not only the absolute ion intensities depend on the pass energy, but the Be-to-Cu ion intensity ratio changes with the pass energy as well. In other words, the Be+ and Cu+ ions from the bombarded CuBe alloy surface have very different ion energy distributions. As indicated by the data in Table 1, the Cu+ ion intensity peaks around 20 eV while the Be+ ions achieves its maximum intensity at a much lower kinetic energy.

Table 1. The Be+ and Cu+ ion intensities measured at differenet pass energies

Pass energy (eV)	Be+ intensity (m/z 9)	Cu+ intensity (m/z 63)
4.8	360 KCPS	<2 KCPS
13.5	120 KCPS	54 KCPS
20.2	100 KCPS	67 KCPS
30.0	92 KCPS	36 KCPS

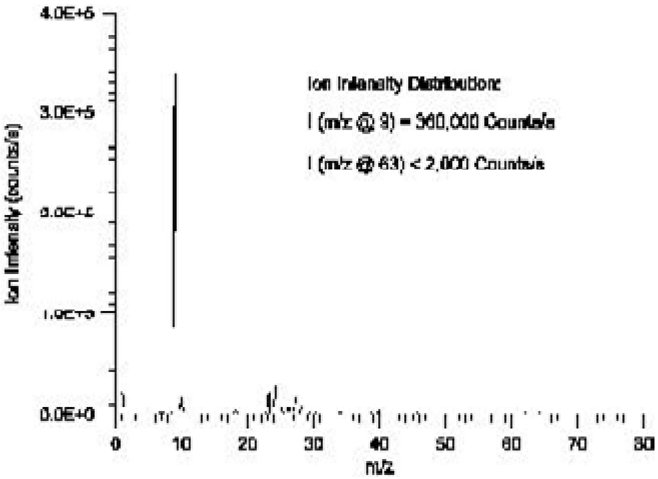

Figure 1. CuBe SIMS Spectrum Collected at the Pass Energy of 4.8 eV.

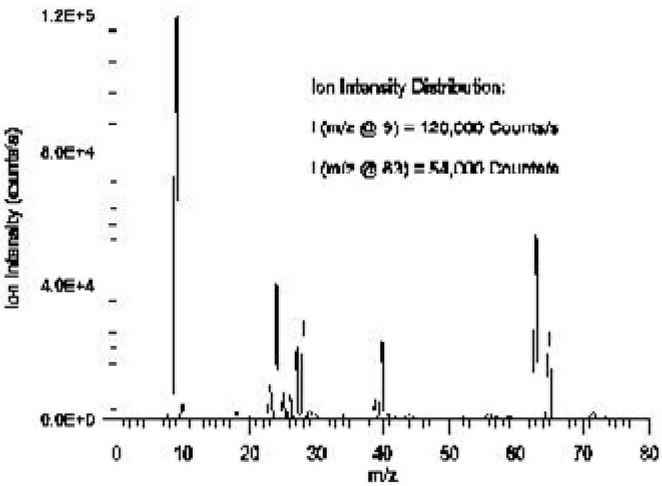

Figure 2. CuBe SIMS Spectrum Collected at the Pass Energy of 13.5 eV.

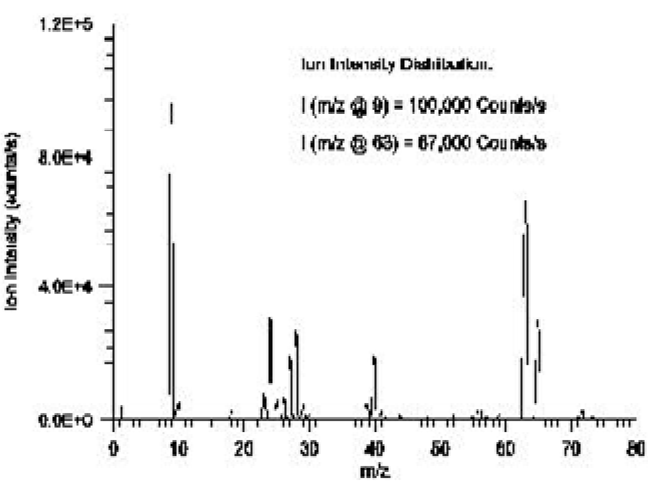

Figure 3. CuBe SIMS Spectrum Collected at the Pass Energy of 20.2 eV.

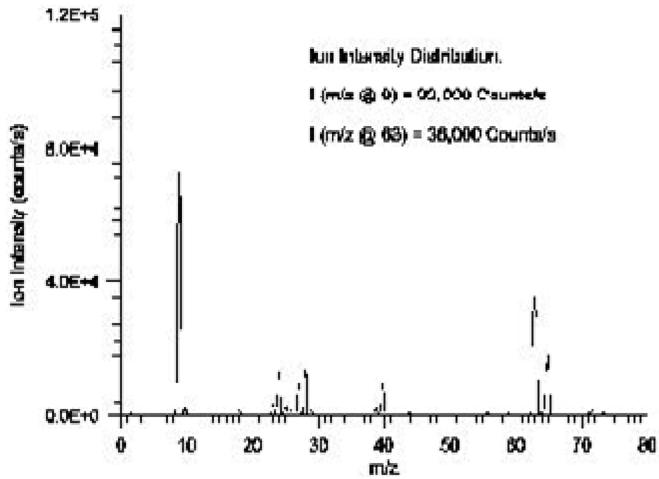

Figure 4. CuBe SIMS Spectrum Collected at the Pass Energy of 30.0 eV.

V. CONCLUSIONS

The SIMS results discussed above demonstrate that the axial energy analyzer can be used to study the energy distribution for various ions from an alloy material. These results also show that the SIMS analysis can be optimized to increase the sensitivity of a given ion when the quadruple mass filter is coupled with the axial energy analyzer.

REFERENCES

1. Wei, J and Schaeffer, R.A. "New Axial Energy Analyzer For Secondary Ion Mass Spectrometry"; Poster presented at the 43rd ASMS Conference on Mass Spectrometry and Allied Topics, May 22-26, 1995.

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