Accelerator Mass Spectrometry with Stable Isotopes

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In order to perform accelerator mass spectrometry with stable isotopes a new **u**ltra **c**lean ion **s**ource (UCS) was developed as described in [1–4]. The first resuts are now available.

1. The ultra clean ion source injector

During the measurements, the cs–current, which is used for sputtering negative ions from the target, reaches values up to a maximum of 166 μA. The transmission from the cs–gun to the target is 89 % (with a cs–current of about 1 μA). Fig. 1 shows the cs–current analysed by the 120°–magnet. The contamination of other alkalimetals is completely reduced as we will see later on. The peak around mass A=129 is assumed to be a part of the cs-current, passing the slits in front of the cup at a lower magnetic field as it would be necessary to follow the beamline.

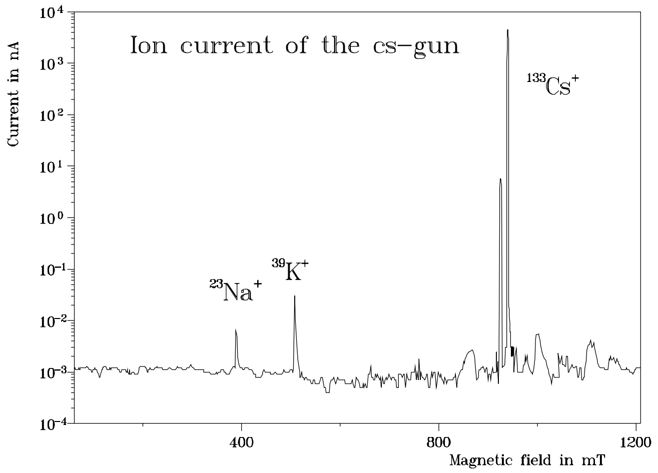

Fig. 1: Ion current of the cs–gun, analysed by the 120°–magnet

Some typical sputter rates for producing negative ions from the target are 2.5 % (^{28}Si), 4.2 % (^{32}S), 11 % (^{35}Cl), and the maximum ^{28}Si–current, while running the source moderately, is 700 nA. This current does not restrict our detection limit at all. Fig. 2 shows the negative ion current analysed by the 90°–magnet. You can see the advantage of AMS according to SIMS: SIMS can not distinguish between e.g. ^{30}SiH and ^{31}P or $^{28}Si_2$ and ^{56}Fe.

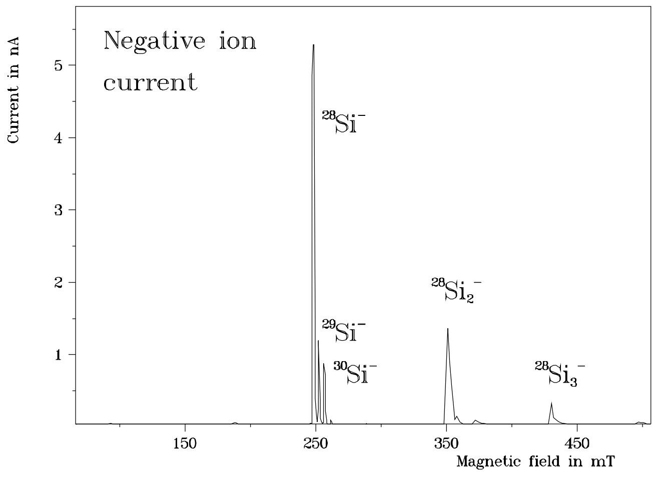

Fig. 2: Negative ion current of the target, analysed by the 90°–magnet

2. Detection limits

Fig. 3 shows five spectrums of sulfur, phosphorus and silicon measured in an ionisation camber. The isotopes are separated by their chargenumber and their energyloss in the detector. By summing up the counts for each isotope, we ascertain, for example, the ratio $\frac{P}{Si}$. In the same way we can determine all ratios of two isotopes in a sample.

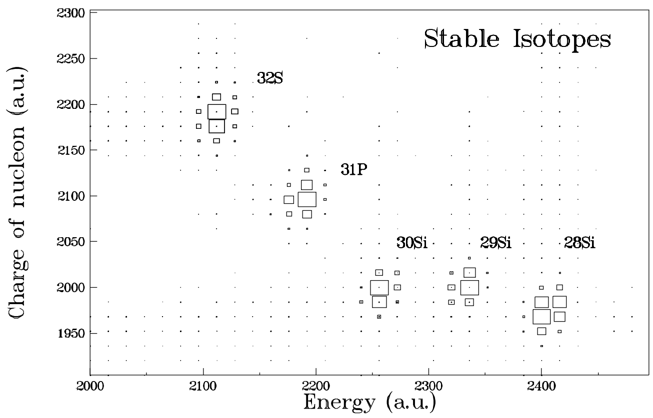

Fig. 3: Spectrums of sulfur, phosphorus and silicon in the detector, one on the top of the other

Measurement of suprapure metals

In order to find a slit material with the least amount of contamination, we measured the P–pollution in Cu, Ag, Ta, Au. It is obvious to use Au or at least Ag instead of Ta for all critical slits.

P–poll. in: Cu: $1.4\,\frac{1}{s}$ Ag: $0.7\,\frac{1}{s}$ Ta: $3.1\,\frac{1}{s}$ Au: $0.6\,\frac{1}{s}$

Measurement of a suprapure silicon sample

To find out the detection limits of the new injector concerning Na, Al, P, Cl, K we investigated a silicon sample with a very low content of all elements ($\frac{\text{element}}{\text{silicon}} < 10^{-11}$).

Our limits are: $\frac{^{23}Na}{Si} = 2 \cdot 10^{-8}$ $\frac{^{27}Al}{Si} = 4 \cdot 10^{-9}$ $\frac{^{31}P}{Si} = 4 \cdot 10^{-8}$ $\frac{^{35}Cl}{Si} = 7 \cdot 10^{-5}$ $\frac{^{39}K}{Si} = 2 \cdot 10^{-11}$

Here we see the strength of analysing the cs–sputter beam. If all ^{39}K from the cs–beam reached the detector it would correspond to a detection limit of $6 \cdot 10^{-1}$.

Crosstalk of the injector

The crosstalk of the injector is also completely reduced within the detection limit. After sputtering 10^{11} Al–ions per second for 10^4 seconds, we detect 10^3 Al–ions per second from the suprapure silicon sample. This corresponds to a detection limit of $4 \cdot 10^{-9}$ as we measured before.

References

[1] C. Faude, et. al., Accelerator mass spectrometry with stable ions, Jahresbericht 1992
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[3] S. Massonet, et. al., Accelerator mass spectrometry with stable ions, Jahresbericht 1993
[4] S. Massonet, et. al., Material Analyses With The New Ultra Clean Ion Source – UCS, Jahresbericht 1994