From ARCA to KRAUT: On the Homestretch for a Seaborgium Reduction Experiment

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Tungsten (W) and Molybdenum (Mo) as homologues of seaborgium (Sg) are used to develop a reduction experiment for Sg. Previous studies [1,2,3] with carrier free amounts of W or on-line produced W had shown that it is possible to reduce W(VI) to W(III) in a heterogenic system with aluminium as reducing agent at a solution temperature of about 80°C.

A modified version of the Automated HPLC Apparatus ARCA II [4] was used to separate unreduced from reduced W. While W(VI) sticks to an anion exchange (AIX) column in 0.1 M HCl/0.1 M HF, W(III) does not form anionic complexes and runs through the column.

W produced on-line at the GSI UNILAC in the reaction $^{nat}Er(^{12}C,xn)^{170,171,172,...}W$ was transported to ARCA II with a He/KCl gas jet system. After a collection time of 120 s, the KCl spot was dissolved in 333 µl of a solution of 0.1 M HCl/0.1 M HF. The solution passed a heated "reduction column" filled with Al wire and was fed onto an AIX column at a flow rate of 1ml/min. As described above, W(III) runs through this column and is collected in the elution fraction. W(VI) sticks to the column. The W in the elution fraction was detected by γ-spectroscopy.

Reference values were taken
a) directly from the cluster jet (100% value)
b) through the empty system (without Al, without AIX) to verify the 100% value
c) through the system without AIX ("elution yield")
d) through the system without Al to demonstrate that W(VI) is not eluted from the column.

The temperature of the reduction column was varied. Because the used thermo-couple could not be placed directly at the reduction column, a temperature calibration was measured correlating the thermo-couple (outer) temperature with the solution (inner) temperature.

The results of the reduction experiments are shown in Fig.1: At room temperature, W is not reduced and is adsorbed on the AIX, while at higher temperature, about 55% of the activity can be eluted. It should be noticed that these 55% are an overall chemical yield (left scale) including losses due to both incomplete reduction and incomplete elution.

If the data are recalibrated for losses in the reduction unit (determined by the reference value c) and the temperature measurement, the on-line data are in full agreement with the offline data (see [3]) .

The size of the reduction column was optimized such that i) the influence of the Al losses due to dissolution in the eluent is minimal and ii) the reduction yield is maximal (about 80% as reached in off-line experiments before).

The results from the experiments with ARCA II led to the development of a special apparatus that will be used in a forthcoming Sg reduction experiment, KRAUT ("Kreisförmige Reduktions-ARCA zur Unterstützung bei Transactinidenexperimenten"; circular reduction ARCA for transactinide experiment assistance).

In KRAUT, the reduction unit is separated from the collection unit and the separation unit to prevent deformations due to heat. The columns used in KRAUT are recycled while the apparatus is running. Thus, the collection time can be reduced in a Sg experiment resulting in higher gas jet yields ($T_{1/2}(^{265}Sg)$=7.4 s [5]). The number of movable parts of KRAUT was reduced to a minimum. This allows a reliable operation during the extended times that are needed to examine and detect nuclear reaction products with cross sections in the sub-nb range.

First tests of KRAUT with Mo from thermal neutron fission of ^{235}U have been performed at the TRIGA reactor in Mainz.

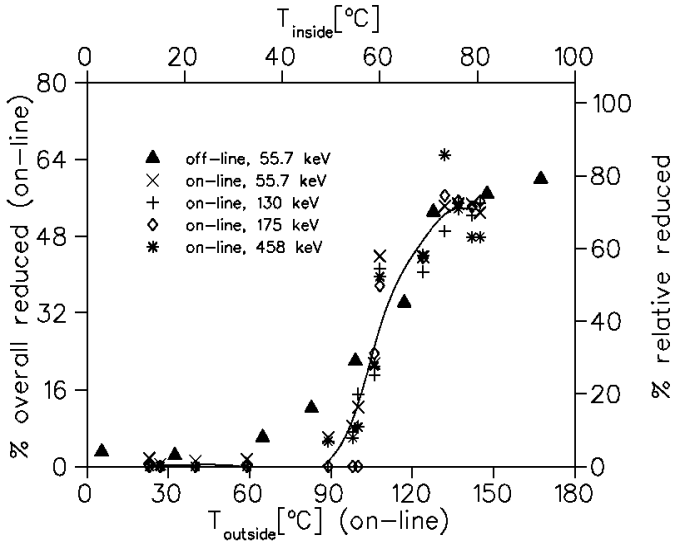

Fig.1: Temperature dependence of the reduction of W(VI) with Al. Reduced and unreduced species are separated by an anion exchange column (Dowex AG1x8). The on-line data (open symbols and fitted line) are in good agreement with the off-line data (solid triangles).

REFERENCES

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