Influence of water on the deposition of osmium tetroxide on alkaline surfaces

A. von Zweidorf[1], R. Angert[1], W. Brüchle[1], R. Eichler[1,3], E. Jäger[1], J. V. Kratz[2], G. Langrock[2], M. Mendel[2], M. Schädel[1], B. Schausten[1], E. Schimpf[1], P. Thörle[2] , G. Wirth[1]

[1]Gesellschaft für Schwerionenforschung, Darmstadt, [2]Institut für Kernchemie, Johannes Gutenberg-Universität Mainz, [3]now at PSI, Villigen

It is known, that the very volatile osmium tetroxide can be deposited directly on alkaline surfaces [1]:

$$2OH^- + OsO_4 \rightarrow [OsO_4(OH)_2]^{2-}$$

This behaviour has been studied to test its application to investigate the chemical properties of hassium tetroxide, which should have similar properties as OsO_4 [2].

In our experiment, Os was produced in-situ using the CALLISTO-setup [3] and irradiating a rotating wheel of barium targets with a beam of ^{40}Ca. OsO_4, formed in the recoil chamber with O_2 in the He gas, was deposited on stainless steel plates, coated with 1 M and, in another experiment, with 2.8 M ethanolic NaOH solution. The deposited amount of OsO_4 decreased with the time of the experiment significantly (Fig. 1).

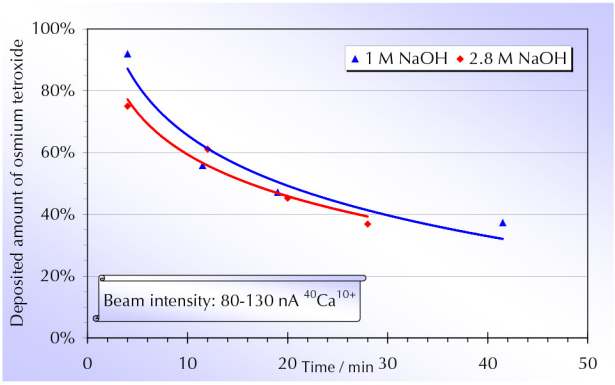

Fig. 1: Deposition of OsO_4 using unmoisturized gases

Because macroscopic amounts of NaOH cannot be fully neutralized by microscopic amounts of OsO_4, and the same behaviour has been observed for both coatings, other effects seem to influence the reaction of OsO_4 with NaOH.

Because this reaction is a classic acid-base-reaction, water may influence this process greatly. The used gases (He, O_2) always contain water as an impurity (typically 5 ppm for He 4.6), so it was supposed, that the deposition process may benefit from an increased amount of water in this chemical system.

To increase the humidity of this system, a special moisturizer was designed [4]. It consists of a thermostated reservoir of water with an adequate quantity for a hassium experiment. It is passed by a flow of 0.05 - 2 l/min helium, which passes thereafter a declusterizer (a glass frit at 200 °C), because water particles may be formed in the moisturizing process. The humidity of the gas was examined with a dewpoint transmitter. The moisturized helium was added after the jet leaves the target chamber (Fig. 2).

To test this method, a rotating wheel with Ce-targets was irradiated with an ^{40}Ar-beam. The formed OsO_4 was deposited using plates coated with 1 M ethanolic NaOH. A mixture of 0.9 l/min He and 0.1 l/min O_2 passed the target chamber and was mixed with 0.05 l/min moisturized He. Keeping the temperature of the moisturizer at 30 °C resulted in a humidity of about 20 g H_2O per kg gas in the moisturized He, leading to about 1 g H_2O per kg gas in the final gas mixture.

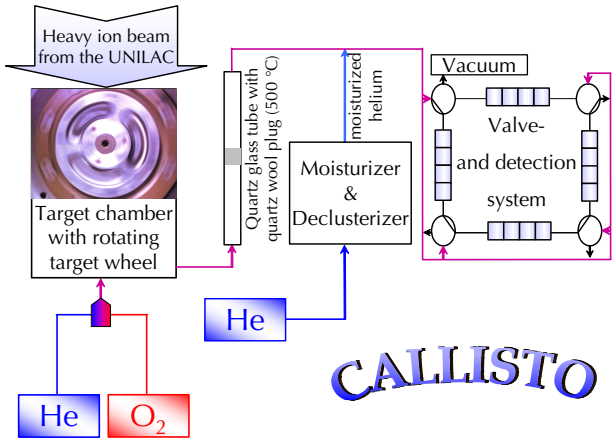

Fig. 2: Scheme of the CALLISTO-setup

Under these conditions is it possible to deposit about 80% of the OsO_4 on the alkaline surface (Fig. 3).

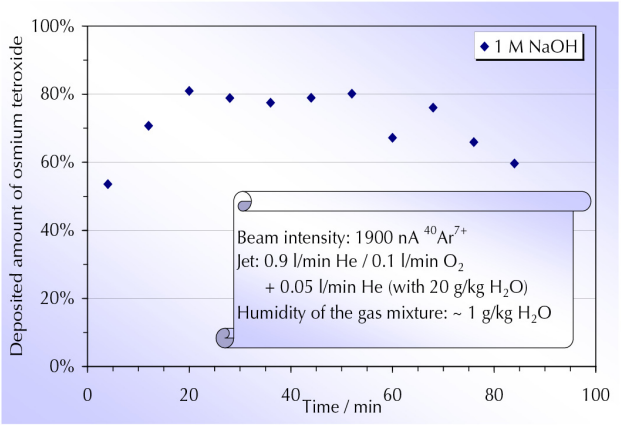

Fig. 3: Deposition of OsO_4 using moisturized gases

This leads to the conclusion, that water is necessary for a fast and nearly quantitative deposition of OsO_4 on sodium hydroxide. The observed decrease after 60 min could be explained with the fact, that disturbing CO_2, which is an impurity of the used gases (1 ppm for He 4.6) and may be formed via a reaction of the graphite beam dump with the jet gases, could react with the alkaline surface, forming the much less absorbing Na_2CO_3.

References

[1] A. von Zweidorf *et al.*, GSI Scientific Report 2001, p. 181
[2] V. Pershina *et al.*, J. Chem. Phys. **115** (2001), 792
[3] A. von Zweidorf *et al.*, this annual report
[4] Pictures are available at *http://www.callisto.ws*