High-Temperature $\alpha$-Spectroscopy with Diamond Sensors

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5th ADAMAS Workshop | GSI | December 15 & 16, 2016
• Introduction to SHE chemistry
• Isothermal Vacuum Chromatography
• Heating Diamond Sensors
• Plans
• Conclusion & Acknowledgements
Some News: 7th Period complete

Introduction: Relativistic Effects
Chemistry experiments with single atoms at a time ( ! )
Fast and efficient approach is needed
Introduction: Identification
Introduction: Techniques

Thermochromatography

 Isothermal Chromatography

\[ T_{ads} \approx T_{50\%} \]
Introduction: Diamonds for COLD (PSI)

\[ \begin{align*}
\text{Temperature, } \degree C \\
\text{Detector \#} \\
\text{Rel. yield / detector, } \% \\
\end{align*} \]

Heating: Techniques

Joule heating (present)  IR-laser heating (future)

Heating: Results up to $\approx 473$ K ($\approx 200^\circ$C)

Temperature dependence:
RT (298 K) --> 473 K.

Long term stability @ 453 K

Heating: Results up to ≈473 K (≈ 200°C)

Summary of all spectroscopic parameters.
Vacuum Chromatography: Setup (PSI)

- Hf hot catcher
- Quartz insert
- Heat shields
- Isothermal oven
- 4-fold diamond detector
- Start- / End-oven
- Read-out
- Quartz chromatography column
- 184Tl\(^+\) beam
- JAEA-ISOL system

PRODUCTION
TRANSFER
CHROMATOGRAPHY
DETECTION
Vacuum Chromatography: T-Profiles

P. Steinegger et al., *Physical Chemistry C* **120** (2015), pp. 7122-7132
Vacuum Chromatography: Detector (PSI)
Monte Carlo simulations in combination with the exp. results allow to derive an adsorption enthalpy.
Efficient transfer
Clean conditions regarding nuclear reaction by-products
Plans: On-line Measurements of Release

Measurement data (68% c.i.)

- Segregation of Zr in Zr
- Segregation of Hf in Hf
- TI release from thin Zr [4]
- TI release from thick Zr [4]

Temperature, K

Release yield, %

0 500 1000 1500 2000 2500

0 20 40 60 80 100 120 140 160

0.01 s

0.1 s

1 s

0.1 s

1 s

d = 25 μm

Plans: Diamonds for COLD (PSI)

- PIN diode
- Cu inlay
- Pt 100
- In sealing
- Diamonds?

Cold end (≈ -180°C)
Warm part (< 40°C)
Conclusion

• First chemistry experiments (adsorption of Tl on SiO$_2$) were successful.
• Satisfying and stable $\alpha$-spectroscopic operation up to 453 K.
• Further heating studies are in preparation (IR-laser heating).
• Applications possibilities of sensors for the chemical characterization of Superheavy Elements are manifold (e.g., NhOH).
Thank you for your kind attention!