TAN'2011

05-11 September 2011, Sochi, Russia

FLNR Radiochemical Research. Latest Experiments.

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| Nuclide | T _{1/2} (s) | E_{α} (MeV) | Reaction | Cross section (pb) | |
|--------------------|----------------------|--------------------|--|--------------------------|--|
| ²⁹⁰ 115 | ~0.6 | 9.95 | ²⁴⁹ Bk(⁴⁸ Ca,3n) | 0.5 | |
| ²⁸⁹ 114 | 2.6 | 9.82 | ²⁴⁴ Pu(⁴⁸ Ca,3 <i>n</i>) | 1.7-8.0 | |
| ²⁸⁸ 114 | 0.80 | 9.94 | ²⁴⁴ Pu(⁴⁸ Ca,4 <i>n</i>) | 5.3-9.8 | |
| ²⁸⁷ 114 | 0.48 | 10.02 | ²⁴² Pu(⁴⁸ Ca,4 <i>n</i>) | 3.6 | |
| ²⁸⁶ 113 | 20 | 9.63 | ²⁴⁹ Bk(⁴⁸ Ca,3 <i>n</i>) | 0.5 | |
| ²⁸⁵ 113 | 5.5 | 9.74 | ²⁴⁹ Bk(⁴⁸ Ca,4 <i>n</i>) | 1.3 | |
| ²⁸⁴ 113 | 0.94 | 9.97 | ²⁴³ Am(⁴⁸ Ca,3 <i>n</i>) | 8.5 | |
| ²⁸⁵ Cn | 29 | 9.15 | ²⁴⁴ Pu(⁴⁸ Ca,3 <i>n</i>) | 1.7-8.0 | |
| ²⁸³ Cn | 3.8 | 9.54 | ²⁴⁴ Pu(⁴⁸ Ca,4 <i>n</i>) | 5.3-9.8 | |
| ²⁸² Rg | 0.5 | 9.00 | ²⁴⁹ Bk(⁴⁸ Ca,3 <i>n</i>) | 0.5 | |
| ²⁸¹ Rg | 26 | SF | ²⁴⁹ Bk(⁴⁸ Ca,4 <i>n</i>) | 1.3 | |
| ²⁸⁰ Rg | 3.5 | 9.52-9.87 | ²⁴³ Am(⁴⁸ Ca,3 <i>n</i>) | 8.5 | |
| ²⁸¹ Ds | 11 | SF / 8.73 (10%) | ²⁴⁴ Pu(⁴⁸ Ca,3 <i>n</i>) | 1.7-8.0 | |
| ²⁷⁸ Mt | 8 | 9.55 | ²⁴⁹ Bk(⁴⁸ Ca,3 <i>n</i>) | 0.5 | |
| ²⁷⁶ Mt | 1.6 | 9.35-9.95 | ²⁴³ Am(⁴⁸ Ca,3 <i>n</i>) | 8.5 | |
| ²⁶⁸ Db | 27 (h) | SF | ²⁴³ Am(⁴⁸ Ca,3 <i>n</i>) | 8.5 | |



EXPERIMENT SCHEME





Chemical Separation of ²⁶⁸Db- 2011

o ⁴⁸Ca + ²⁴³Am

| | 2005 | 2011 |
|-----------------------------|------|----------------------------------|
| ²⁴³ Am (mg cm-2) | 1.2 | 0.5 |
| E transm. | 0.9 | 0.4 |
| | | |
| K(Db/Ac)sep. | | 10 ⁴ -10 ⁵ |
| K(Db/Ac)chem. | 104 | 104 |



Lanthanum fluoride radiochemical separation flow chart (4 h)





Extraction radiochemical separation flow chart (4-5 h)











Results

| N⁰ | T _{irrad} | ſ | Separation | ${ m E_{top}}/{ m E_{bot}}$ + | Group | T _{reg} | T _{mes.} |
|----|--------------------|-----------------------------|------------------|-------------------------------|-------|------------------|-------------------|
| | hr | | | n | | (EOB) | (total) |
| | | | | (MeV) | | | hr |
| 1 | 45 | 6.0·10 ¹⁷ | LaF ₃ | 10 / 70 + 0 | 5 | 6 h 20 m | 496 |
| 2 | 44 | $6.1 \cdot 10^{17}$ | LaF ₃ | | | | 240 |
| 3 | 41 | 5.7·10 ¹⁷ | LaF ₃ | 3 / 40 + 2 | 5 | 70 h 45 m | 480 |
| 1 | 16 | 6.6·10 ¹⁷ | LaF | 30 / 20 + 1 | 4 | 37 hr | |
| 4 | 40 | | Lar ₃ | 15 / 5 + 1 | 4 | 74 h 20m | 430 |
| 5 | 48 | $7.7 \cdot 10^{17}$ | LaF ₃ | | | | 240 |
| 6 | 45 | 4.0·10 ¹⁷ | LaF ₃ | 20 / 20 + 2 | 4 | 12 hr | 760 |
| 7 | 47 | 6.7·10 ¹⁷ | Extr.C | 15 / 3 + 2 | 4 | 18 hr | 720 |
| 8 | 46 | $7.1 \cdot 10^{17}$ | Extr.C | | | | 240 |
| 9 | 21 | 3.3.1017 | Extr.C | | | | 240 |

| 10 | 20 | 2.6·10 ¹⁷ | Extr.C | 25 / 10 + 2 | 4 | 65 h 30 m | 648 |
|----|----|------------------------------|--------|-------------|---------------------|-----------|-----|
| 11 | 44 | 6.5·10 ¹⁷ | Extr.C | | | | 240 |
| 12 | 22 | 3.0.1017 | Extr.C | | | | 240 |
| 15 | 48 | 5.5·10 ¹⁷ | Extr.C | | | | 240 |
| 16 | 43 | 5.4.1017 | Extr.C | | | | 240 |
| 17 | 47 | 6.1.1017 | Extr.C | | | | 240 |
| 18 | 47 | 3.4.1017 | Extr.C | | | | 240 |
| 19 | 24 | 3.3·10 ¹⁷ | Extr.C | 57/+1 | 5 | 36 hr | 254 |
| | | | | | $4 \mathrm{gr} - 5$ | | |
| Σ | | 8.9· 10 ¹⁸ | | 8 | $5 \mathrm{gr} - 3$ | | |

| Exp | DGFRS I (2003) | DGFRS II (2011) | DGFRS sum | Chemistry I (2004) | Chemistry II (2005) | Chemistry III (2011) | Chemistry sum | Sum | |
|---------------|-------------------|--------------------------------|--------------------------------|-----------------------|------------------------|-----------------------------|------------------|------------------------------|--|
| $N_{ m SF}$ | 3 | 18 | 21 | 15 | 5 | 8 | 28 | 49 | |
| $T_{1/2}$ (h) | 16^{+19}_{-6} | 30 ⁺⁹ ₋₆ | 28 ⁺⁸ ₋₅ | 32^{+11}_{-7} | 18^{+13}_{-6} | 23^{+13}_{-6} | 27^{+6}_{-4} | 27.4 ^{+4.6} -3.4 | |
| σ (pb) | | 8.5 ^{+6.4} -3.7 | | | | 6.0 ^{+3.6} -2.4 | | | |



NRC-7, August 25, 2008 Budapest, Hungary

Fluoro complex formation of Rf and Db

Y. Nagame for JAEA – RIKEN - Niigata Univ. - Osaka Univ. - TMU-Kanazawa Univ. - GSI - Mainz Univ. collaboration



Anion-exchange behavior of Db in 14 M HF



CHEMISTRY of ELEMENT 113

113 – 7s² 7p_{1/2} – less reactive and more volatile than TL

-△H_{ads} (Au): TI = 240 kJ/mol (S.König) 113 = 158.6 (V. Pershina)

- ΔH_{ads} (inert surf) = 14 kJ/mol

Sublimation enthalpy



Chemistry of the Element 113



DGFRS







⁴⁸Ca + ²⁴³Am

²⁴³Am- target - 1,1 mg cm⁻² (^{nat}Nd - 30 μ g cm⁻²)

⁴⁸Ca $E_{U-400} = 273 \text{ MeV}, E_{mid. target} = 248 \text{ MeV}$ I ~ 10 eµA

Irradiation 24.03.2010 - 14.04.2010

∫ 4.7·10¹⁸

Gas flow rate 2 L·min⁻¹

Hg-185 DISTRIBUTION





Energy, keV



DGFRS

25 March 2010 14:25:04

Thermochromatography of SHE









| | 100 | |
|----|-----|-----|
| 97 | +21 | MeV |

| Nalfa2 | Nalfa3 | Nalfa4 | NSF |
|--------|--------|--------|-----|
| 240 | 286 | 21208 | 7 |

N_{Random}~0.002

⁴⁸Ca + ²⁴⁹Bk







a). Cumulative alpha spectrum from 16 pairs of detectors
c). Cumulative alpha spectrum from 8th pair of detectors

b). Cumulative spectrum of fission fragments from 16 pairs of detectors d). Cumulative spectrum of fission fragments from 8th pair of detectors



a). Cumulative alpha spectrum from 16 pairs of detectors c). Cumulative alpha spectrum from 4th pair of detectors

b). Cumulative spectrum of fission fragments from 16 pairs of detectors d). Cumulative spectrum of fission fragments from 4th pair of detectors





The deposition of ¹⁸⁵Hg compared to the deposition of ²⁰⁹At in the isothermal detector array at 0°C together with Monte-Carlo simulation of the depositions.

THANK YOU FOR YOUR TIME!

Mendeleev periodic table of the elements (2011)



Лантаноиды Lanthanides

| Церий | 58 | Празеодим 59 | Неодим 6 | 0 Прометий 61 | Самарий | 62 Европий | 63 Tagomessi 64 | Tepfinit | 65 Диспрозий 6 | б Гольмияй б | 37 Эрбий | 68 | Tymuk | 69 Mm | optival 70 | Лютеций | 71 |
|---------|-----|-----------------|------------------|-----------------|---------------------|--------------|-----------------|------------------------|---------------------|-----------------|-------------|-----|----------|--|------------|-------------|--------------|
| Ce | 475 | Pr | Nd | Pm | .s Sm | | | # Tb | Dv | Ho | Er | | Tm | ······································ | b | s Lu | - |
| 140,115 | 67 | 140,90765 | 6772 144,24 | 7008 [145] | 7264 1062 150,36 | 7520 151,965 | 157,25 | 7901 1314 158,92534 | 8230 1300 162,50 | 1411 164,93032 | 8795 167,26 | 900 | 168,9342 | 8321 173 1545 173 | 04 | 174,967 | 9641 1663 |
| Center | | a riastooyinoin | 3510 Hebocymatan | JOBS PROVIDENTS | 200 300 000 | 170 European | The Contraction | The Helphan | 321 Oysprosessi | 2561 (100110011 | 2004 Crown | | | 1946 | | Se L'ORUGHI | 1000 |
| | | | | | | | | | | | | | | | | | |

Actinides Актиноиды srer 6.02 13510 1345 [247] U Pu Am Cm g Cf 5 Es . Md 🖀 Pa 🚜 Fm INO NO Th Np ≝ Lr 238,028 [244] [243] [251] [257] [258] [259] [262]



S-ЭЛЕМЕНТЫ

р-элементы

103

Н - символ 1,00794-атомный номер 1s¹ - электронная конфигурация 13.59844 - - на потенциян и онизации, эВ 0,0899 - плотность кг/м¹ - 259,34 - температура плавления,"С - 252,87 - температура киления,"С



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