Mitglied der Helmholtz-Gemeinschaft

ASGARD 5th Project Meeting

July 1th – July 3th 2014, (Lancaster, England)

Progress Report of Beneficiary No 5: Jülich

Domain 2:

WP 2.1 Inert Matrix Fuels

WP 2.3 Conversion from solution to oxide pre-cursors

- Task 2.3.1 Co-conversion by sol-gel routes
- Task 2.3.2 Co-conversion by impregnation of solid matrixes

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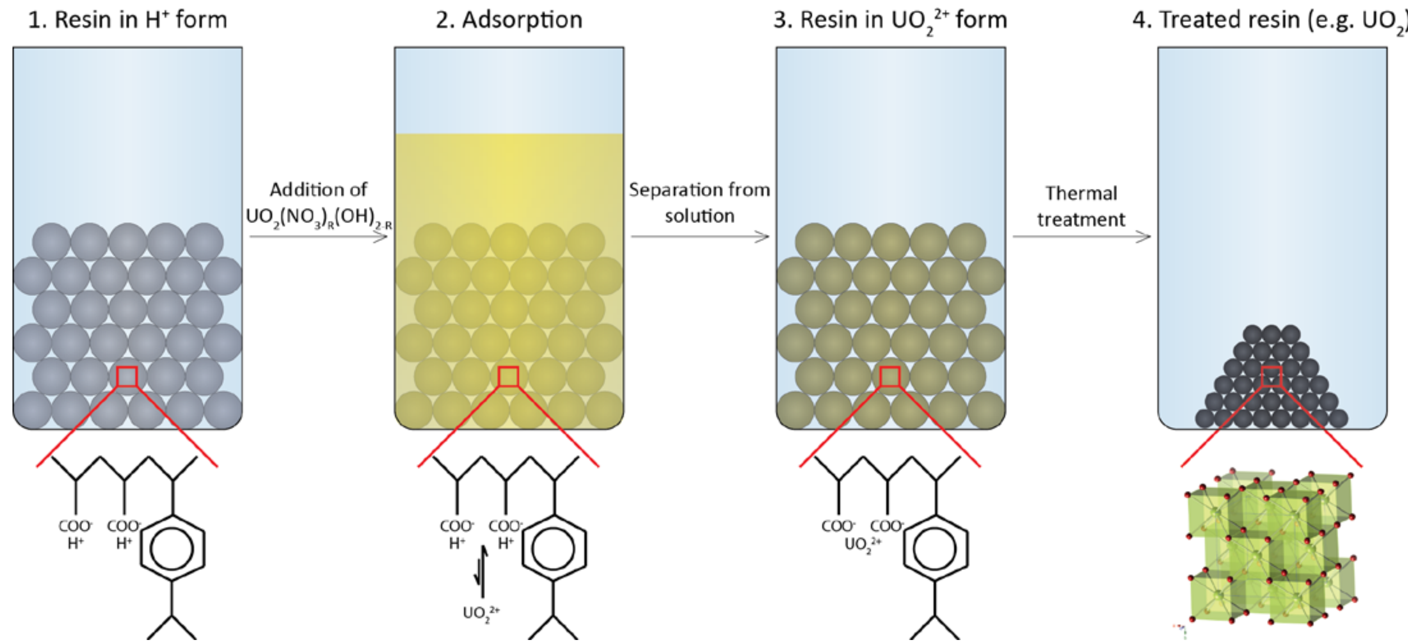
– Nukleare Entsorgung und Reaktorsicherheit

The weak-acid resin process

Introduction

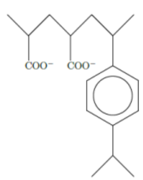


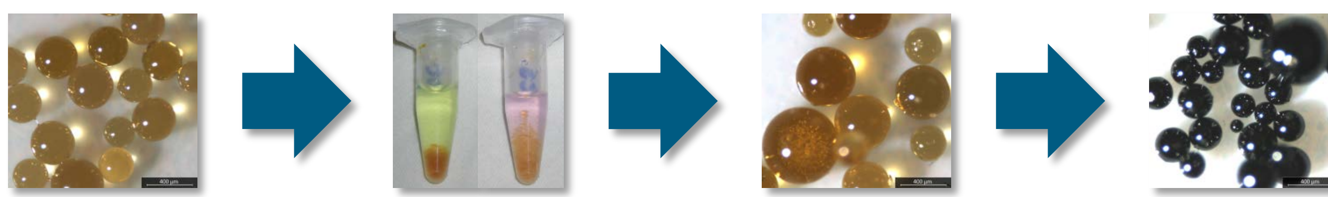
Amberlite IRC-86

Gel-type

Q = 10.7 meq·g^{-1}

pH: 5 ≤ pH ≤ 10



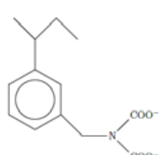


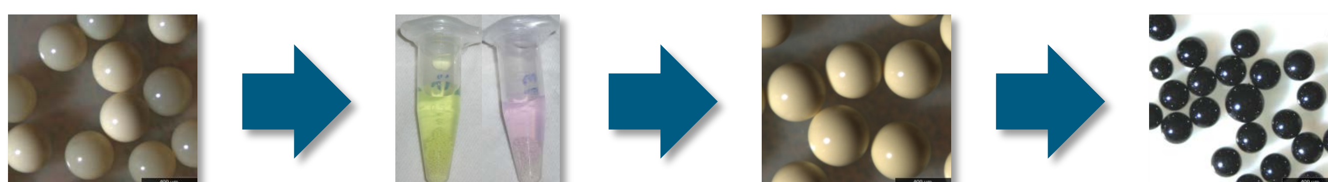
Lewatit TP-207

Macroporous

Q = 6.9 meq·g^{-1}

1.5 ≤ pH ≤ 9





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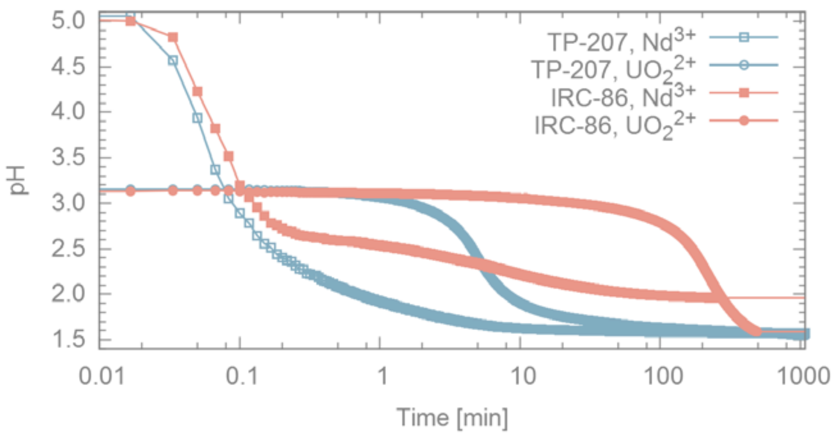
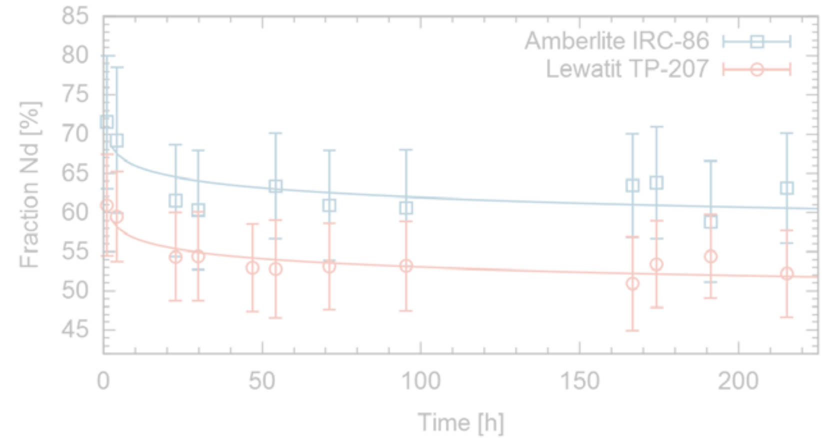
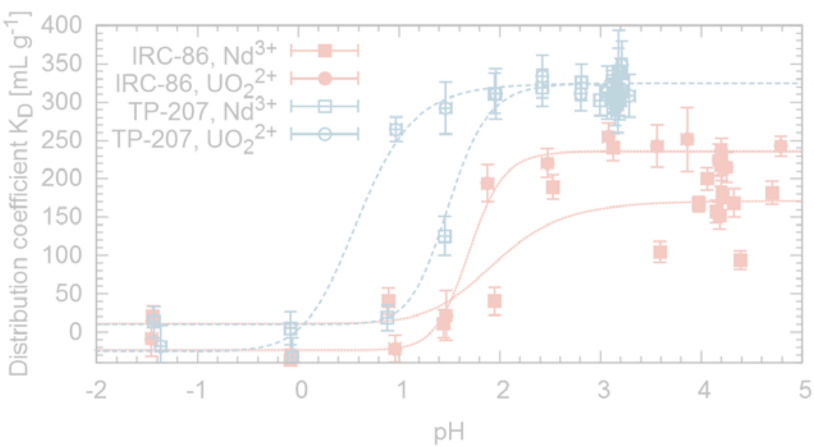
The weak-acid resin process

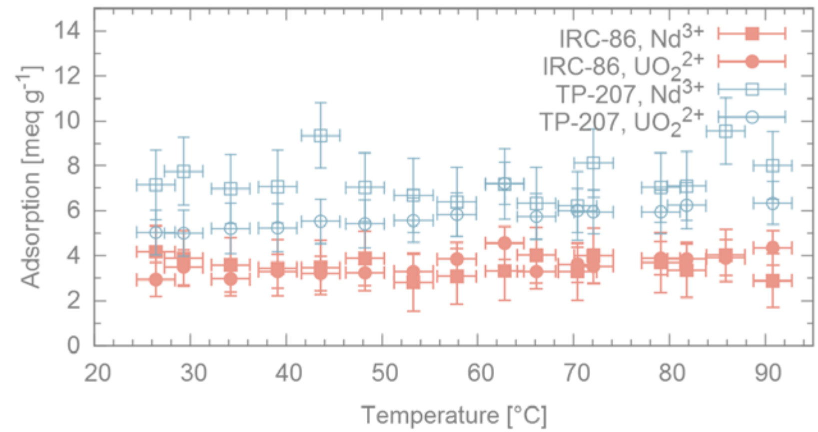
Retrospect

PIR-4: Adsorption of Nd^{3+} and UO_2^{2+} on ion exchange resins







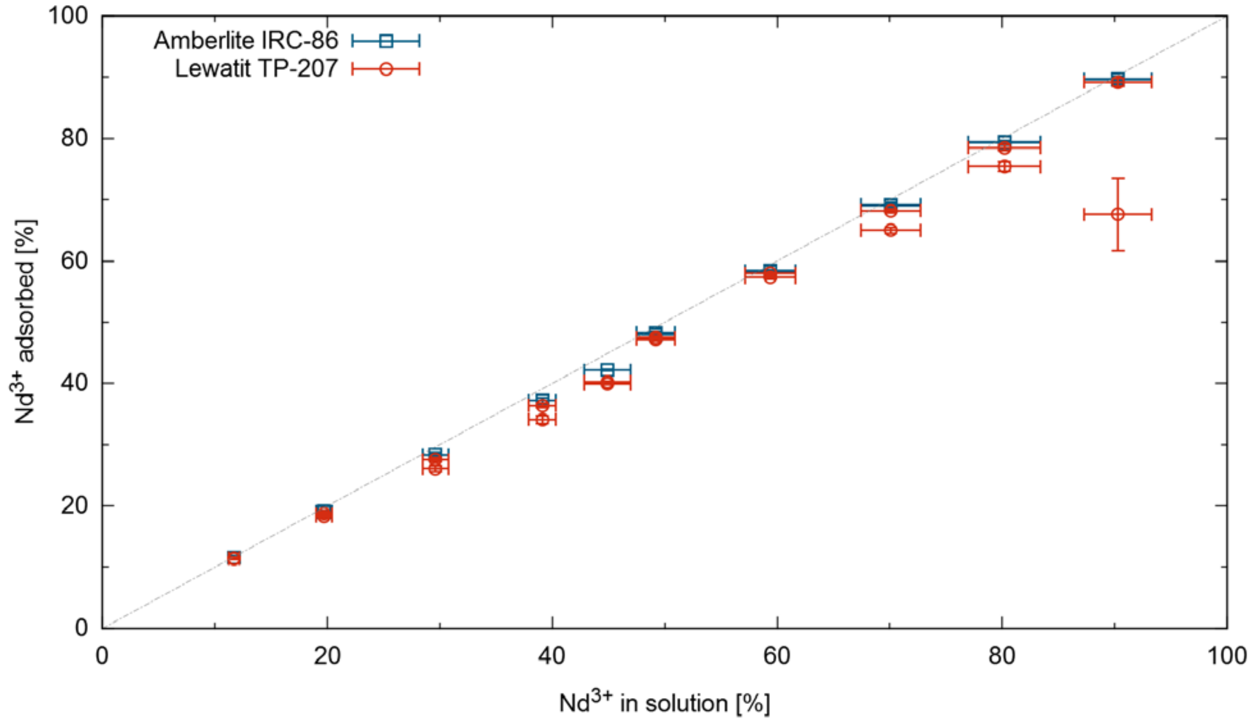


The weak-acid resin process

Retrospect

Resins (Lewatit TP-207 & Amberlite IRC-86) successfully loaded

0 – 100 % Nd up to 0.43 $g \cdot g^{-1}$



t = 18 h
$c(M^{+})$ = 0.5 $mol \cdot L^{-1}$
pH > 2.6
$\vartheta \approx$ 70 °C
$n(M^{+}) > Q$

The weak-acid resin process

Treatment in inert atmosphere

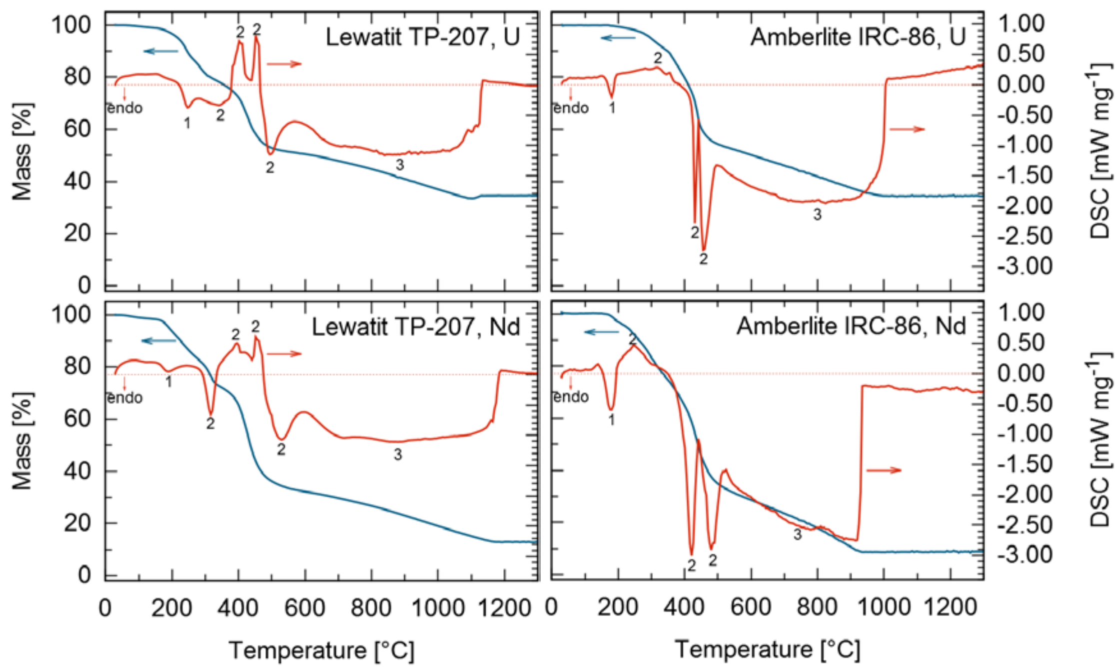
TG/DSC measurements to determine thermal behavior

Resin specific effects observed, no ion specific effects

Effects in accordance to Abdelmonem et al. 1976 (different resins)

3 effects observed:

1. Dehydration
2. Resin specific
3. C + O → CO (g)



The weak-acid resin process

Treatment in inert atmosphere

Resins treated in inert atmosphere (Ar)

No broken particles observed

Qualitative XRD analysis:

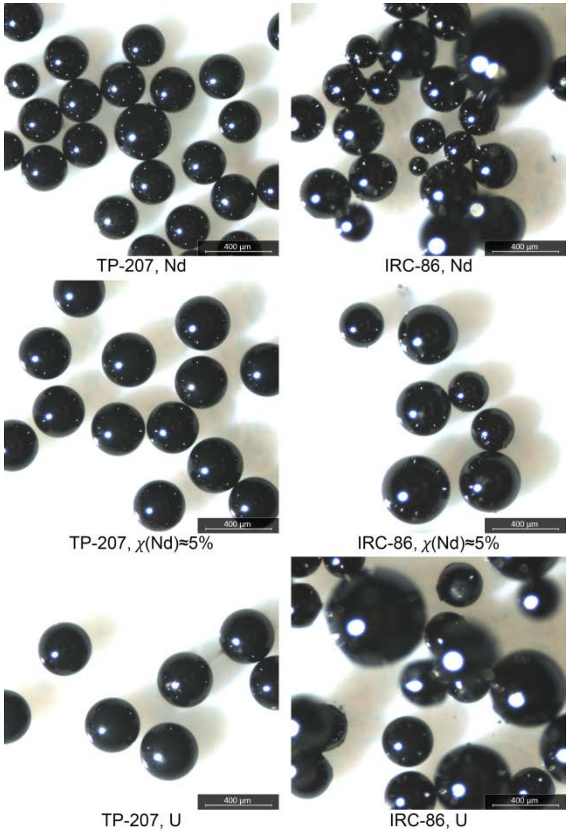
600 °C: U_3O_8 & Nd_2O_3

900 °C: UO_2 & Nd_2O_3

1300 °C: U_3O_8 & Nd_2O_3

└ $UC_{1-x}O_x$ expected

- Oxidation of $UC_{1-x}O_x$ to U_3O_8



Micrographs with a magnification of 50× of resins treated at 600 °C in argon

The weak-acid resin process

Treatment in inert atmosphere

Amberlite IRC-86 treated at 900 °C in argon

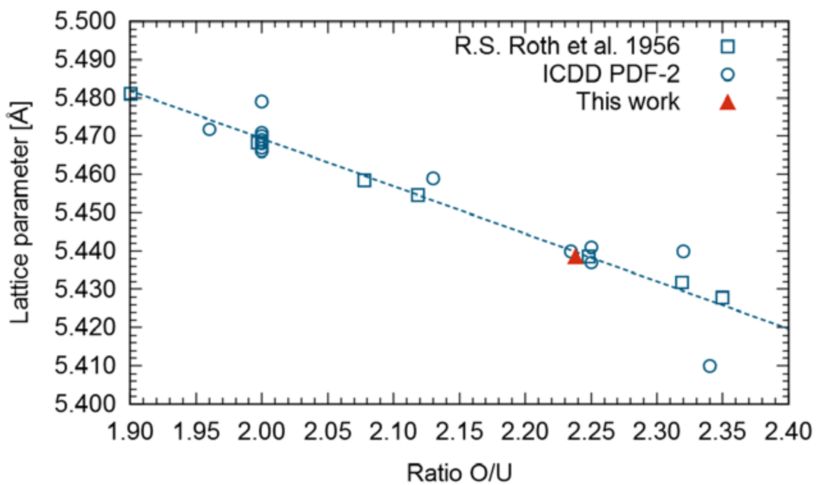
XRD measurement → UO_2 & Nd_2O_3

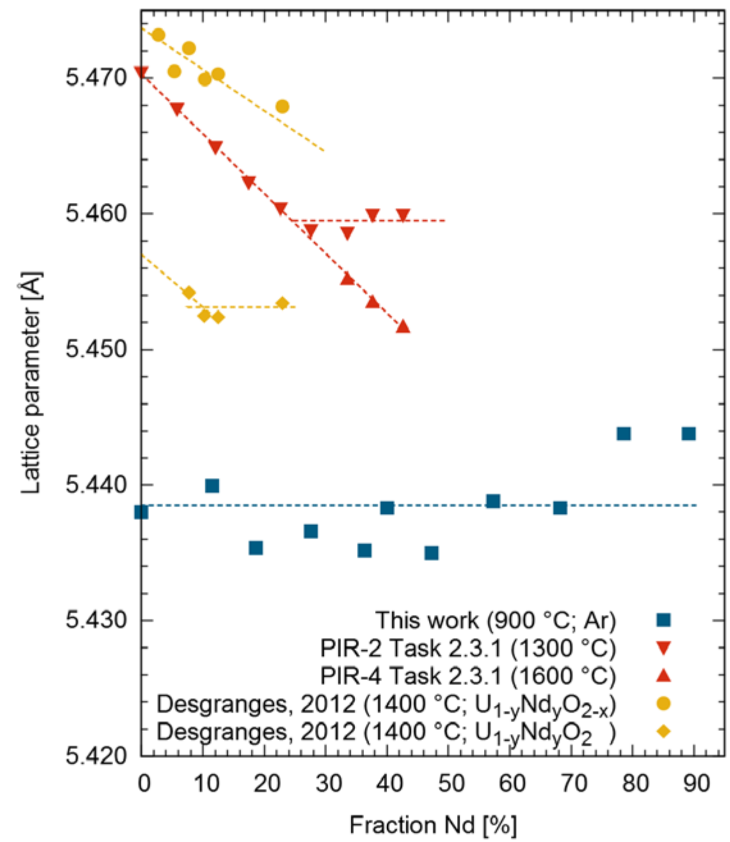
No equilibrium solid solution formed

- Carbon impurity

Low lattice parameter

- High O/U ratio (= 2.24 ≈ U_4O_9)

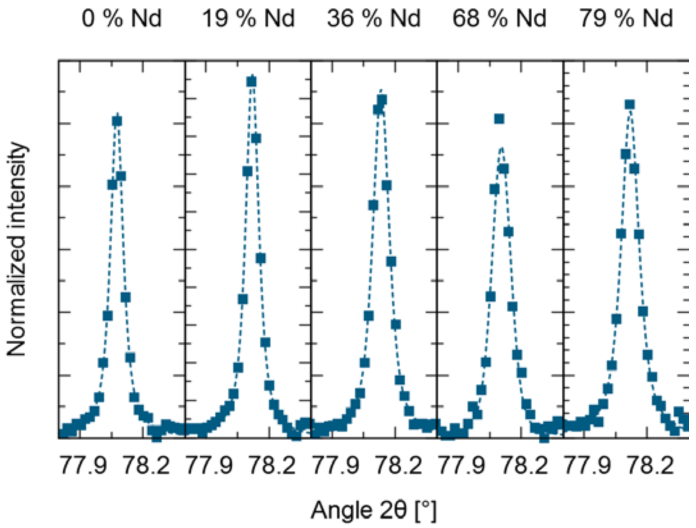




The weak-acid resin process

Treatment in reducing atmosphere

1. Resins heated to 900 °C in air
   - Amberlite IRC-86: most particles broken
2. Lewatit TP-207 particles heated to 1600 °C in H_2/Ar
   - > 50 % Nd: Particles (partially) melted
3. XRD measurement
   - Single phase detected
4. Calculation lattice parameter
   - Nelson-Riley method



Mitglied der Helmholtz-Gemeinschaft

The weak-acid resin process

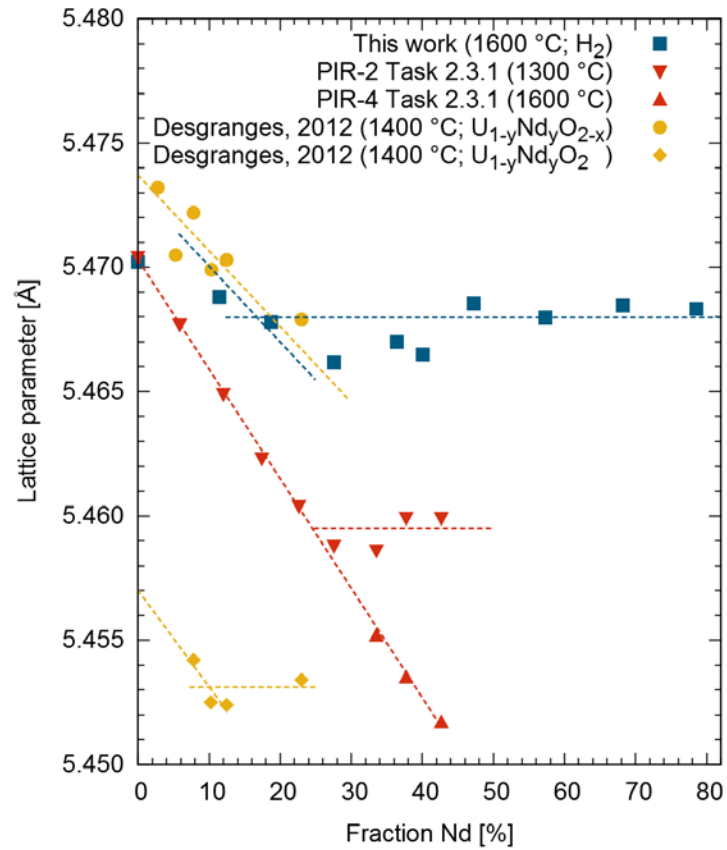
Treatment in reducing atmosphere

Decrease of *a* according to Vergard’s law expected

- $a_{AB} = a_A(1 - \chi_B) + a_B\chi_B$

No equilibrium solid solution formed:

- Low density
- Carbon impurity
- Insufficient time



The weak-acid resin process

Summary

U_3O_8/UO_2 and Nd_2O_3 particle produced in Ar atmosphere

- 600 °C: U_3O_8
- 900 °C: UO_2
- No equilibrium solid solution obtained

UO_2 and particles produced in H_2/Ar atmosphere (1600 °C)

- No equilibrium solid solution obtained

Outlook

- Thermal treatment in oxidizing atmosphere
- Increase of sintering time/temperature
- Measurement of C impurities in particles
- Influence of concentration on adsorption

Acknowledgment

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Thank you for your attention!