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Progress status on pelletized and sphere-packed Am-bearing oxide fuels developments

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► **To cite this version:**

F. Delage, S. Bejaoui, S. Lemehov, W. Maschek, J. Somers. Progress status on pelletized and sphere-packed Am-bearing oxide fuels developments. 13 IEMPT - 13th International Exchange Meeting on Partitioning and Transmutation, Sep 2014, Seoul, South Korea. cea-02933171

HAL Id: cea-02933171

<https://cea.hal.science/cea-02933171>

Submitted on 9 Sep 2020

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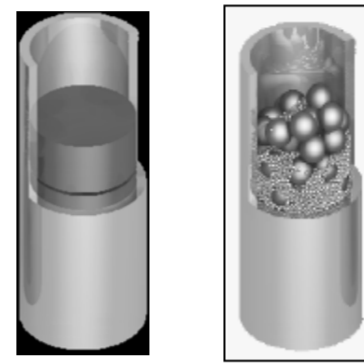
on behalf of the consortium



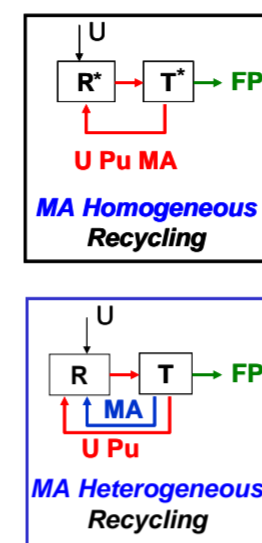
Objectives

Compare spherepacked and pelletized MA-bearing oxide fuels

- Fabrication process developments
- Behaviour under irradiation:
 - Post-Irradiation Examinations
 - Semi-integral irradiation test
 - Modelling and simulation
- SFR core preliminary design & safety performance



Considering 2 MA-recycling options:



- MA homogeneous recycling

→ MA bearing Driver Fuels (MADF): $(U,Pu,MA)O_{2-x}$, MA < 5%

- MA heterogeneous recycling:

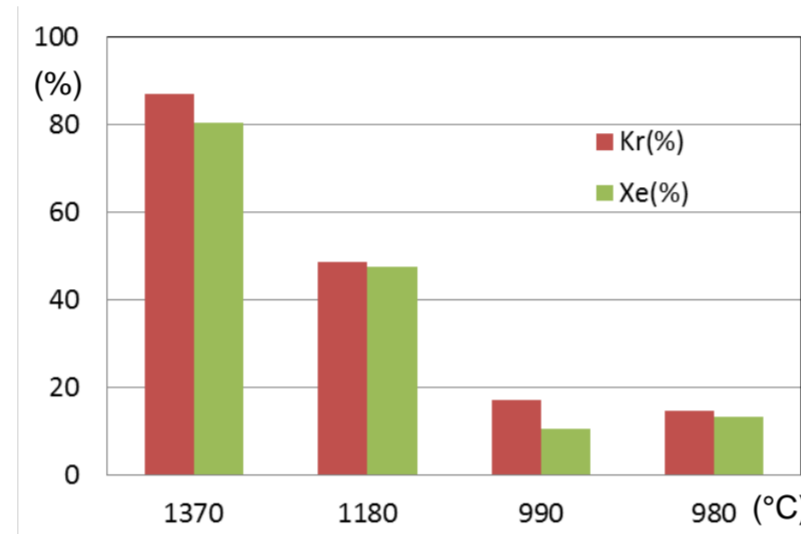
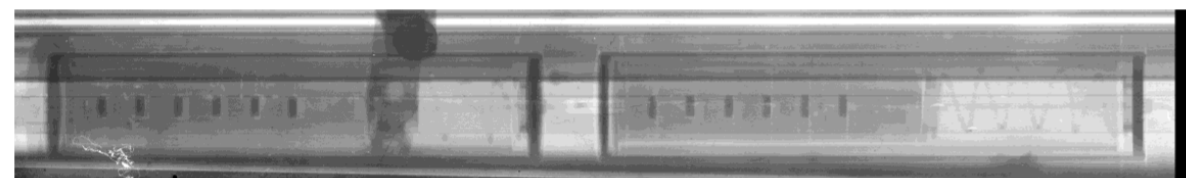
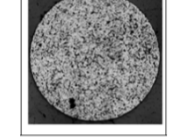
→ MA Bearing Blankets (MABB): $(U,MA)O_{2-x}$, MA ~10-20%

Experiments on (U,Am)O₂ fuels

• PIE of MARIOS pins (irradiated in HFR within FP-7 FAIRFUELS)

→ Measurement of He release and U_{0.85}Am_{0.15}O_{2-x} swelling

- Fuel samples kept at constant T° during ~300 EFPD
- 2 microstructures: regular vs tailored porosity

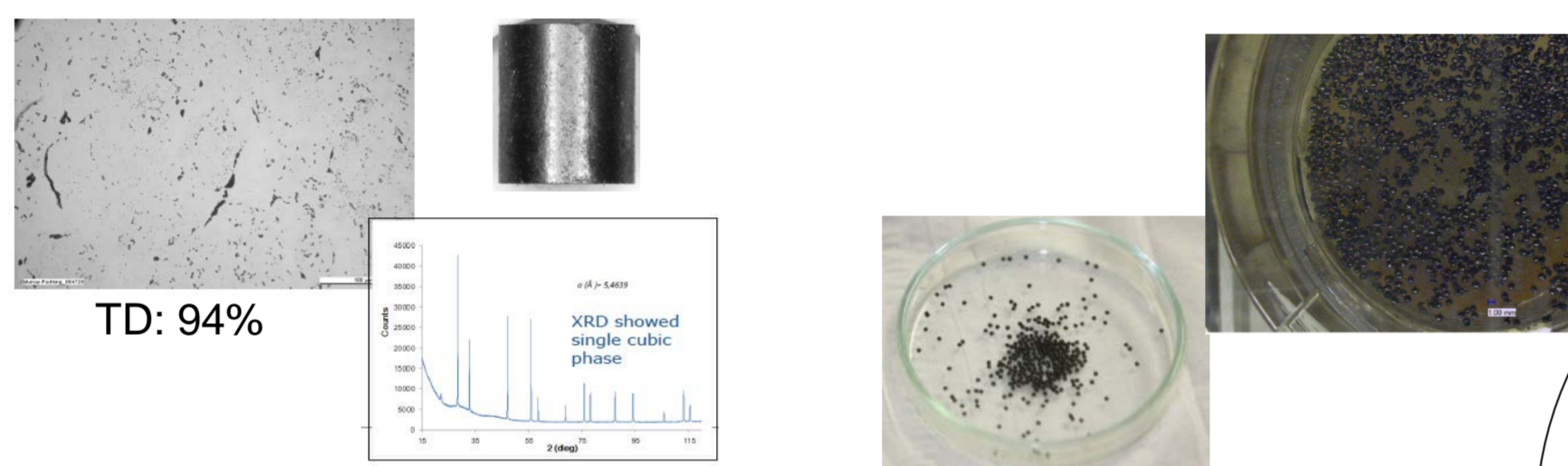


- ~100% helium released
- Strong T° dependence of FG release

→ Next step: fuel density & microstructure

• Design, manufacture and implementation in HFR of MARINE

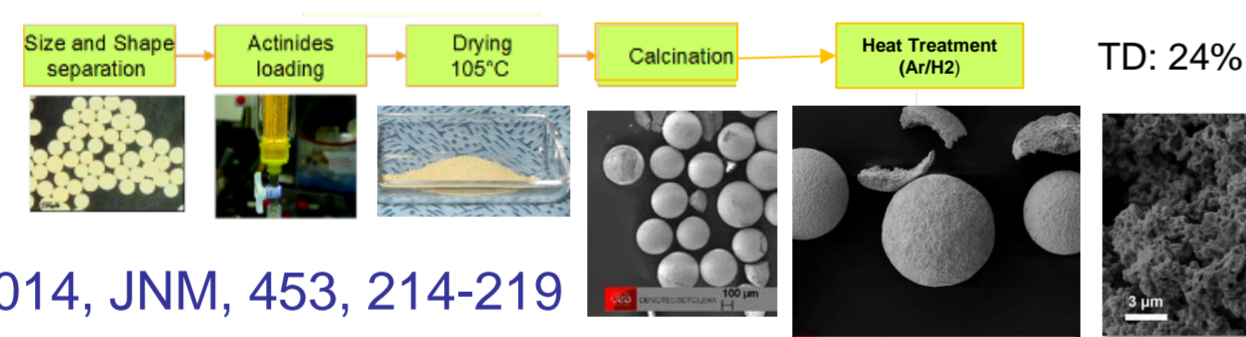
→ 2 stacks of U_{0.85}Am_{0.15}O_{2-x} pellets & beads (800 μm + 50μm) respectively in instrumented pins to be irradiated in HFR under similar conditions (300 EFPD, ~1000°C at EOI)



→ Irradiation start expected by 4th term 2014

• Investigation of the Weak Acid Resin route

→ U_{0.9}Am_{0.1}O_{2-x} beads



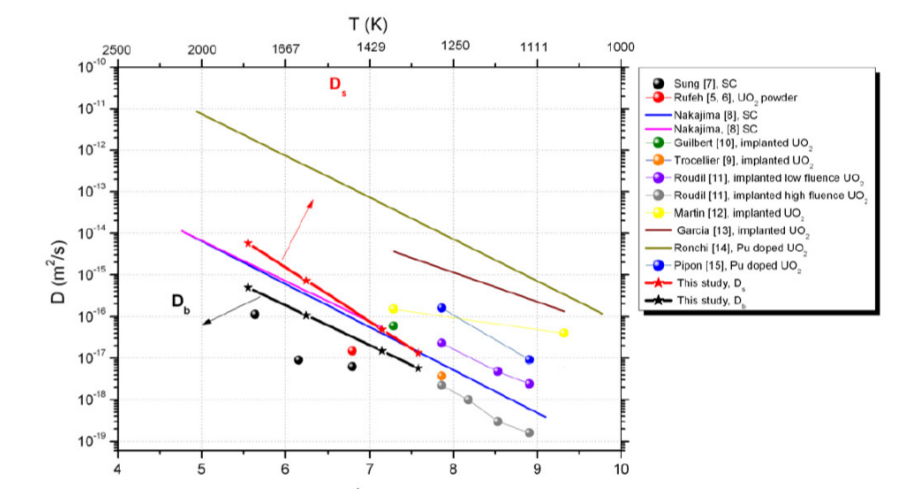
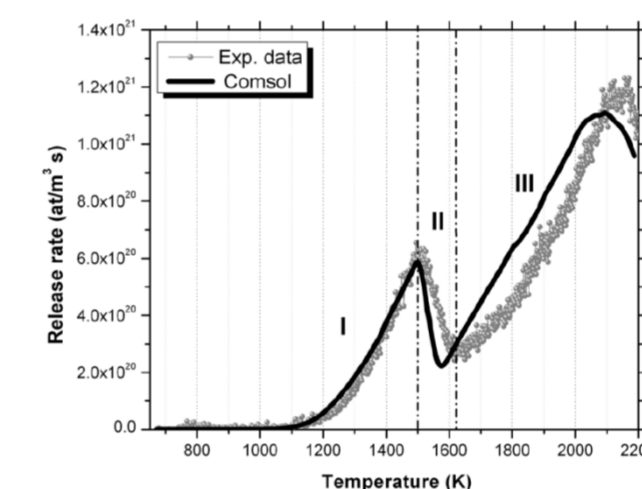
→ E. Remy et al., 2014, JNM, 453, 214-219

Modelling & Simulation of fuel behaviour: pelletized & spherepacked MADF & MABB fuels

→ Upgrades of fuel-performance calculation codes GERMAL(CEA), MACROS(SCK-CEN), SPHERE/SPACON(PSI) & TRANSURANUS(ITU)

- Collection of experimental data
- Development + implementation in codes of models & correlations describing relevant phenomena

→ ex.: He release mechanisms (Z. Talip et al., 2014, JNM, 445, 117-127)



→ Last step: recalculation of SPHERE irradiation: MADF - pellets & sphere-packs & SUPERFACT-1: pelletized MABB-type fuels irradiated in PHENIX in the 1990's

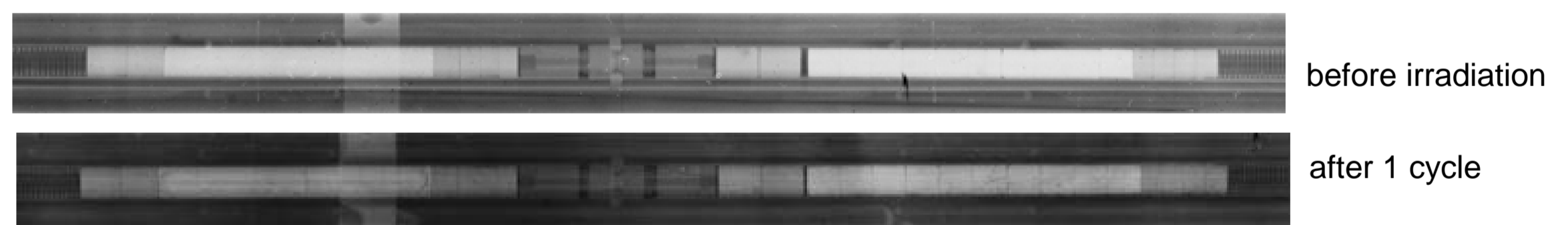
Experiments on (U,Pu,Am)O₂ fuels

• PIE of SPHERE pins (currently under irradiation in HFR within FP7-FAIRFUELS)

→ Influence of Am on performance of (U,Pu)O_{2-x} fuel shaped as pellets & microspheres

- U_{0.76}Pu_{0.21}Am_{0.03}O_{1.98} synthesized by sol-gel processes
- 2 stacks: pellets & beads of 2 size fractions (50 & 800 μm)
- Tailored spectrum (Hf shielding), ~330 W.cm⁻¹, T_{clad} ~530°C, up to 5at% (~May 2015)

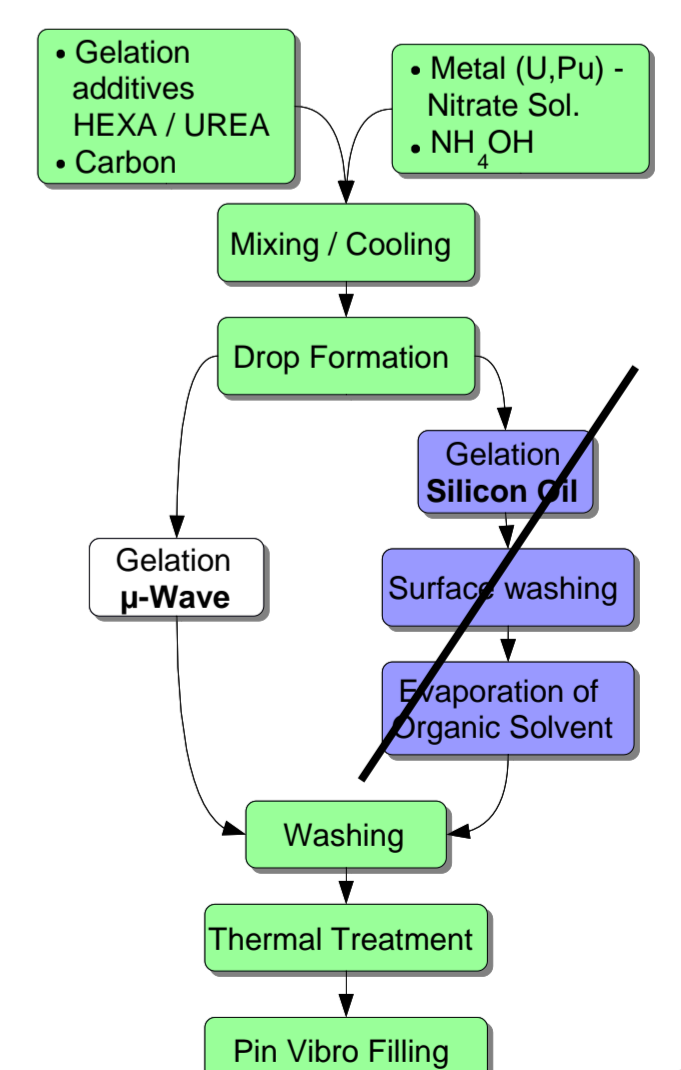
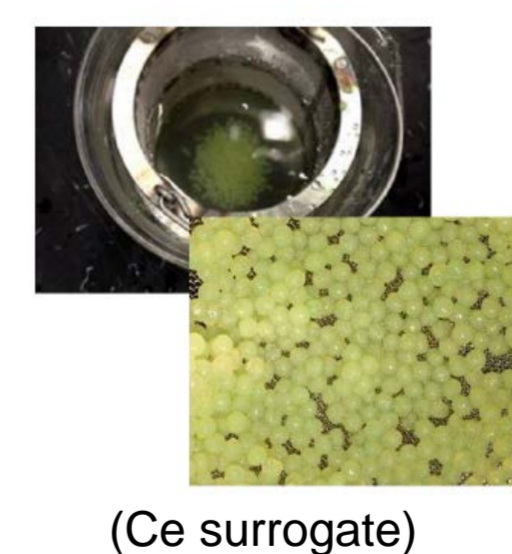
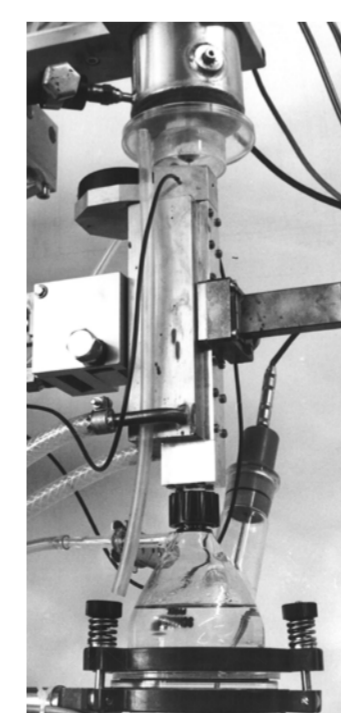
→ Neutron-radiography results (courtesy of FP-7 FAIRFUELS)



→ NDE start by 2nd semester 2015

• Investigation of microwave internal gelation

→ Simplification of sol-gel fuel fabrication processes



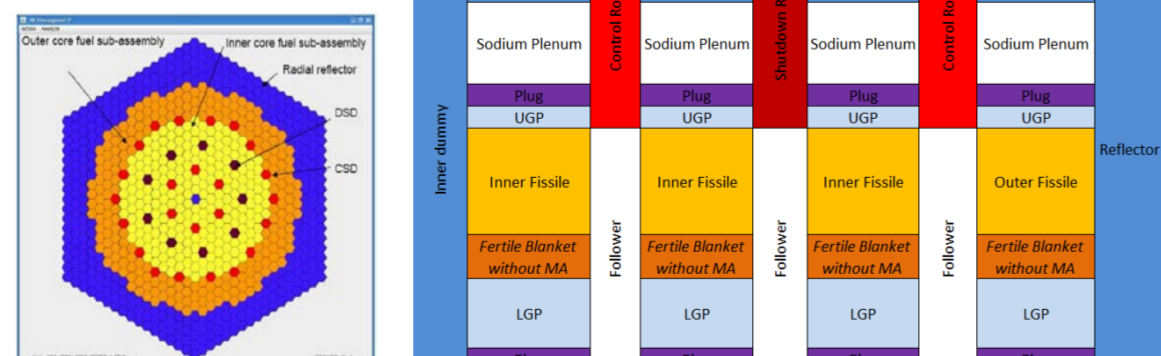
Pre-design & safety performance of a spherepacked MADF fuelled SFR core

→ Linking spherepacked shaped fuel fabrication and irradiation behaviour to problematic of core physics, design and safety performance

- Review of core fuelled with (U,Pu)O₂ and MADF pelletized fuels designed in FP-7 CP-ESFR [1]

[1] A. Rineiski et al., 2013, Proceedings conf. FR-13, ref. IAEA-CN-199-399

→ core OO-ESFR



- Assessment of the sphere-packed fuel impact: fuel density? Margin to fuel melting? Thermal conductivity?

→ L. Andriolo et al, 2013, proceedings conf. INES-4 (Tokyo, 2013)

→ On-going: collection and review of basic data & preparation of safety codes (RELAP5-3D, SIMMER-III, SAS4A, LPS & MAT5DYN)

Education & training

- Placement of trainees in Master year for 6 months in organisations involved in PELGRIMM

→ 5 internships (year 2014) for contributions to RTD actions related to the project

- Financial support to PhD students & Post-Doctorates to attend summer schools, conferences, workshops, ...

→ 9 grants already allocated (application forms available on <http://www.pelgrimm.eu/>)