FUELBASE : a thermodynamic database for advanced nuclear fuels

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ACTINET
A NETWORK FOR ACTINIDE SCIENCES

OBJECTIVE

To develop a **thermodynamic database** which will constitute a **flexible tool** to perform thermodynamic calculations on advanced fuel materials (oxides, carbides, nitrides fuels) for future reactors

CONTEXT

Gas Fast Reactor ⇨ High operating temperature ~ 1273 K

Fuel kernel	Liner	Matrix
(U,Pu)C ((U,Pu)N)	**W-Re** (Mo-Re, Nb-Zr)	**SiC** (TiC, ZrC)

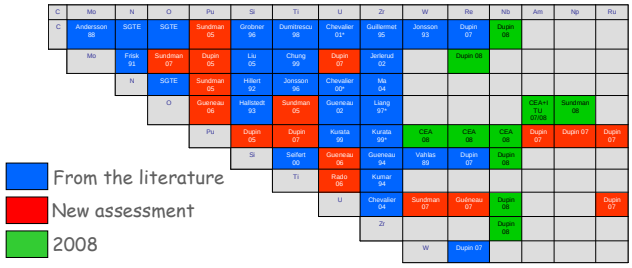
- **Chemical interactions between the fuel components (T< 2273 K)**
  ⇨ **U-Pu-C + W-Re-Mo-Nb-Zr + Si-C phase diagrams**
- **Fuel material processing**
  ⇨Phase equilibria + vapor partial pressures during processing
  ⇨Ex: (U,Pu)C made by reduction of $(U,Pu)O_2$ by C ⇨ **U-Pu-O-C**
- **Incorporation of the Minor actinides**
  ⇨Partial press. of MA + μ(C) in (U,Pu,MA)C ⇨ **U-Pu-Am-Np-Cm-C**
- **"Chemistry" of the irradiated fuel** versus temperature and burnup
  ⇨**U-Pu-Am-Np-Cm-C + Fission Products**

Sodium Fast Reactor

- Fuel materials: [$(U,Pu)O_2$,(U,Pu)C]
- **Incorporation of the Minor actinides** (MA: Am,Np,Cm)
  ⇨Phase equilibria + Partial pressures of MA + μ(O) in $(U,Pu,MA)O_2$
  ⇨ **U-Pu-Am-Np-Cm-O**
- **"Chemistry" of the irradiated fuel** versus temperature and burnup
  ⇨**U-Pu-Am-Np-Cm-O + Fission Products**
- **Interaction fuel materials / Na**
  ⇨ **U-Pu-O (C) / Na**

PROGRESS (2005-2008)

Binary systems



Ternary systems

2006 / 2007
- C-N-Ti, C-Si-Ti, C-Mo-Ti, C-Mo-Si, U-Pu-Zr
- U-Pu-O, U-Pu-C, U-O-C, U-Si-C, U-Zr-C, U-C-Mo, U-C-Re, U-C-W

2008
- C-Re-W, C-Re-Mo, Pu-C-W, U-Pu-Mo, U-C-Nb, Pu-C-Mo, C-Nb-Zr, Pu-C-Nb, Pu-C-Zr, Pu-O-C, Pu-C-Re

COLLABORATIONS

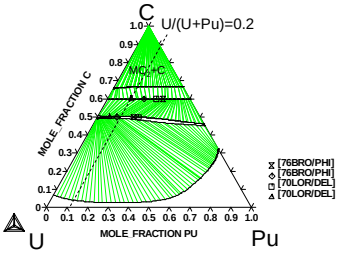
The FUELBASE database is developed in collaboration with:
- ITU (R. Konings, D. Manara, P. Gotcu)
- University of Rennes (H. Noel)
- University of Sheffield (H. Kinoshita)

within the ACTINET network for ACTINIDE SCIENCES

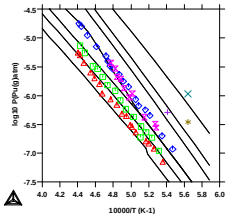
FUEL MATERIALS

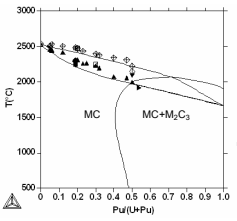
Carbide (U,Pu)C

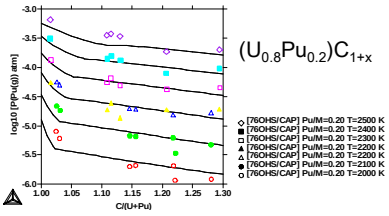
Phase diagram U-Pu-C



Pu partial pressure in U-Pu-C

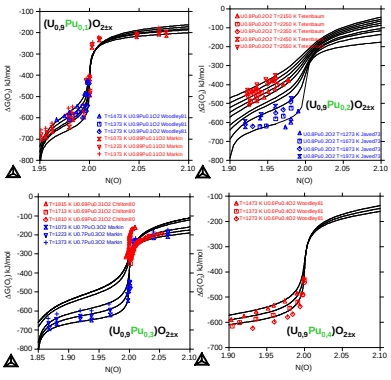




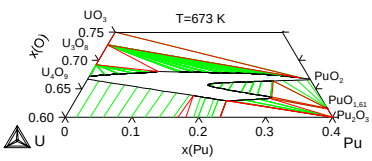


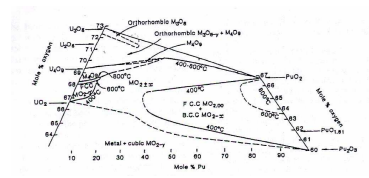
Oxide $(U,Pu)O_{2\pm x}$

$\mu(O_2)$ in $(U,Pu)O_{2\pm x}$

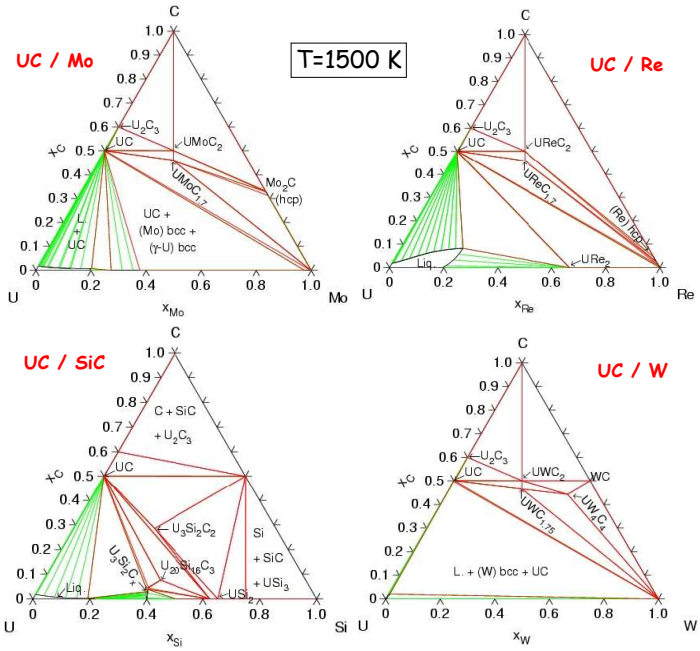
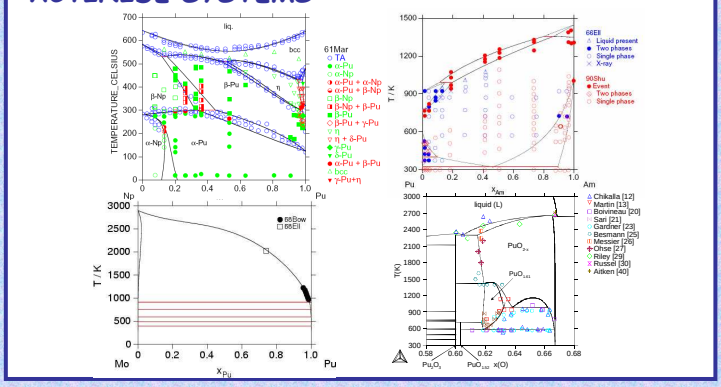


Phase diagram U-Pu-O





FUEL / CLADDING INTERACTION



ACTINIDE SYSTEMS