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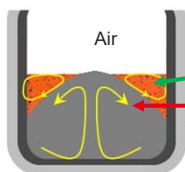
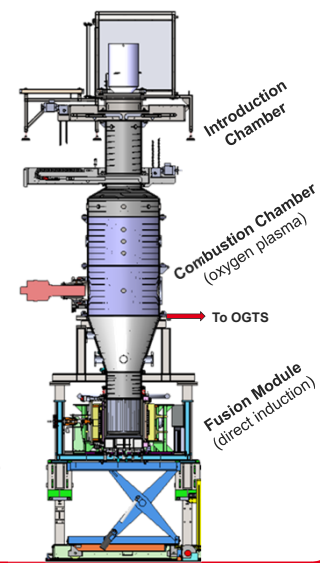
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## Context and objectives

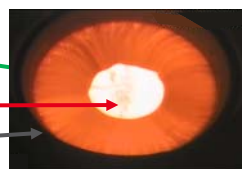
Process for Incineration and Vitrification In-Can (PIVIC, 2013-2023) for the treatment and conditioning of solid technological wastes

- Extremely wide range of wastes in nature and composition
  - Organic: PVC, PE, neoprene... from gloves, glovebox windows, wipes
  - Minerals: aluminosilicates and borosilicates from filters, prefilters, glass fibers
  - Metals: aluminum and stainless steel from electric devices, defective mechanical products, tools
- Maximize waste loading (in particular Al incorporation)
- Highly reducing environment imposed to the glass melt
- No boron addition to the glass composition (alkaline borates volatilization + neutronic counting of containers)



Schematic cross section of fusion module by direct induction in the metal

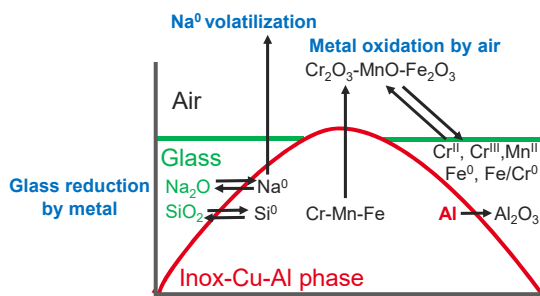
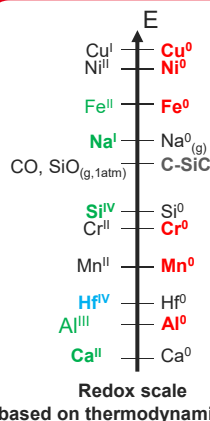
1400°C  
 Glass melt:  $\text{Na}_2\text{O}-\text{CaO}-\text{Al}_2\text{O}_3-\text{SiO}_2 + \text{HfO}_2$  as actinide surrogate  
 Metal: Fe - Cr - Cu - Ni - Mn - Al  
 Crucible: C-SiC



In situ process top view of the crucible

⇒ Study of NCAS ( $\text{Na}_2\text{O}-\text{CaO}-\text{Al}_2\text{O}_3-\text{SiO}_2$ ) system and interactions between glass melt and liquid metal at high temperature (1400°C)

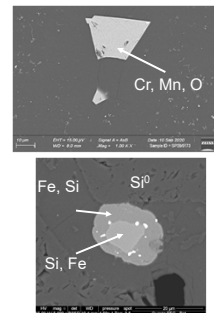
## Glass melt/liquid metal interactions



Schematic representation

Observations from ICP and SEM/EDS analyses:

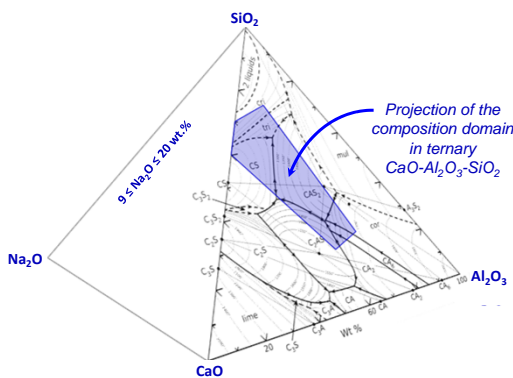
- Na volatilization (20<sub>rel.</sub>%)
- $\text{Cr}_2\text{O}_3$ , MnO,  $\text{Cu}_2\text{O}$  and  $\text{Fe}_2\text{O}_3$  ↗
- $\text{SiO}_2$  ↘ and  $\text{Al}_2\text{O}_3$  ↗
- $\text{Si}^0$  formation



## Glass formulation and rheological studies

### Main objectives

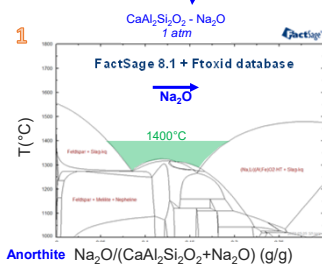
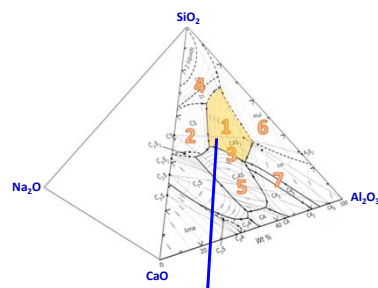
- Define one single glass frit (vitrification adjuvant) to treat all PIVIC solid technological waste
- Maximize  $\text{Al}_2\text{O}_3$  incorporation into the glass / glass-ceramics
- Prevent any potential risk of glass melt "freezing" at 1400°C



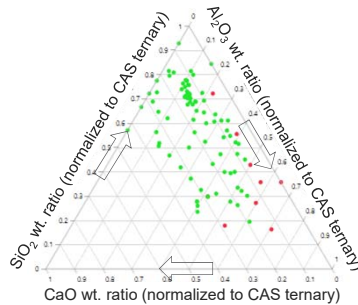
Composition domain for PIVIC glass formulation studies

### Methodology

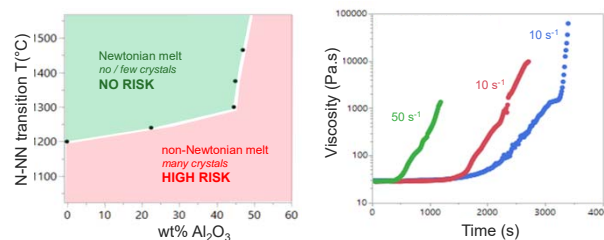
1. Thermodynamic modeling of the NCAS system



2. Elaboration and microstructural characterization of glass samples



3. Rheology of crystallized glass melt



## Conclusions

- Accurate knowledge of glass melt/liquid metal interactions, actinides distribution and NCAS glass melt rheology
- Definition of one single glass frit to treat all PIVIC solid technological waste
- Maximization of Al incorporation (~55wt%  $\text{Al}_2\text{O}_3$  in the final glass-ceramics)

## Acknowledgements

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