

Summary of the session:  
Experimenting, Corrosion and  
Mass Transfer

B.Pint

# First session Tuesday PM

- Christian LATGE, CEA: Sodium coolant: Chemistry, quality control and in-service on-line monitoring
  - Overview of sodium fast reactor technology
  - Sodium purification is extremely important, <3ppm O
  - Starting purity and remove “pollution” during operation
  - Review of cold trap and impurity monitoring technology evolution
- Natalia KHARITONOVA, MEPHI (virtual): Some coolant chemistry issues for corrosion mitigation strategy in advanced fission reactors
  - Discussed protective oxides formed in HLM (Heavy Liquid Metals: Pb, PbBi) and SCWR (Supercritical water reactors, different from fossil systems)
  - Chemistry control with time to maintain oxides: O/H addition to control O potential
  - Regulatory rules cover these issues and regulations are evolving

# First session Tuesday PM, continued

- Martina MOLINARI, Sapienza University of Rome: Water chemistry control as a corrosion mitigation strategy
  - Experimental work in flowing water at high temperature and pressure
  - 100 bar, 300°C: Eurofer97 and 316L, change KOH and O<sub>2</sub> content
  - Attack increased with O<sub>2</sub> content but no localized attack
- Andrea M. JOKISAARI, INL, USA: Corrosion testing needs and considerations for additively manufactured materials in nuclear reactors
  - Additive manufacturing (AM) may enable future NPP and FPP
  - US NRC has AM technical action plan
  - Current research program focusing on type 316 stainless steel
  - Experimental work in the context of codes and standards
  - AM concern about surface finish and microstructure changes impact on corrosion

# First session Tuesday PM, continued

- Alberto UBALDINI, ENEA, Italy: Experimental investigation of corrosion of nuclear materials & radioisotopes release under aggressive leaching conditions
  - Concern about the effect of radiation on aqueous corrosion
  - Difficult to study experimentally in the laboratory
  - H<sub>2</sub>O<sub>2</sub> to simulate radiolysis: 30% peroxide at 70°C
  - Rapid attack of Mo, also Fe and W
- Rueben M. HOLMS, Kyoto Fusioneering, Japan: Kyoto Fusioneering: materials compatibility testing facilities
  - Multinational company founded in 2019, 100+ employees
  - Supporting companies develop FPP
  - High temperature SCYLLA blanket concept: SiC/SiC composites
  - UNITY-1: forced convection FLiBe loop facility, ≤1000°C, 4T magnet

# First session Tuesday PM, continued

- Viktor RUKOSUEV, MEPhI, Russia (virtual): Corrosion of Uranium Dicilicide in Vapour under Simulated PWR Conditions
  - Studying  $U_3Si_2$  in high temperature and high pressure water
  - Formation of  $UO_2$  causes disintegration of silicide at 350°-450°C
  - May be OK for 24 h at 350°C

# Second session Wednesday AM

- Bruce PINT, ORNL, USA: Overview of recent compatibility assessments in flowing experiments: Sn, Li, Pb-Li and molten salts
  - Overview of liquid metals and molten salts issues for fusion
  - Salt purification critical for good compatibility
  - Fission experience with low Cr, Ni-based alloys in FLiBe salt not FPP relevant
  - Modeling behavior of Fe-based alloys in Cl and F salts
- Jinsuo ZHANG, Virginia Tech: Corrosion Tests of SS 316 in Static and Flowing U-bearing Fluoride Salts
  - FUNaK salt purified by HF, Ar-H<sub>2</sub>, electrochemistry (purification is essential)
  - Spinning test 2-4 m/s: Fe and Cr deposited on glassy carbon crucible
  - Tested perform in Ar glovebox at 650°C
  - Small pits in 316 after exposure to flowing salt

# Second session Wednesday AM, continued

- Uttam JAIN, BARC, India: Compatibility of Alumina with Eutectic Pb-Li
  - Patent for making Pb-Li using LiCl as Li source
  - Alumina evaluated at 450°-550°C in Pb-Li
  - After 48h/550°C, see LiAlO<sub>2</sub>, not at lower temperature
- M. IZERROUKEN, Nuclear research centre of Draria, Algeria: Radiation damage effect on structural and mechanical properties of inert ZrN layer: corrosion mitigation in LBE Cooling environment
  - Zr-30N as a barrier between U-Mo and Al
  - Proton irradiated 700 nm thick coating
  - Change in surface roughness after irradiation

# Second session Wednesday AM, continued

- Jinsuo ZHANG, Virginia Tech: Lessons learned from operation of a forced convection chloride molten salt
  - Testing 316 and 709 in flowing  $\text{MgCl}_2 + \text{KCl} + \text{NaCl}$  at  $650^\circ\text{C}$
  - More attack on 709 than 316; deeper attack in static salt (no surface metal loss)
  - Issues with valve, weld failure and pump: challenging to run salt loop!
- Marco UTILI, ENEA, Italy: Borated water chemistry control for DTT vacuum vessel
  - Borated water for neutron shielding during high performance phase of DTT
  - $\text{H}_3\text{BO}_3$ : 8000ppm B, 95% $^{10}\text{B}$ , pH=3.6
  - 12 week tests
  - Li (5.7 and 57 ppm) and K can increase pH and reduce corrosion
  - More susceptible to cracking after exposure to borated water
  - Used Gaspirini data (Thurs. presentation) for OSCAR model predictions



# Second session Wednesday AM, continued

- X.CHEN, KIT, Germany: Simulation of gas injection into liquid with SIMMER
  - 2D and 3D SIMMER code developed at JAEA, CEA and KIT
  - Experiments of gas in water to evaluate code
  - Calculated void fraction higher than experiments
  - SIMMER gives narrower plume than experiment

# General thoughts

- Synergy evident for water chemistry issues in NPP and FPP
  - Similar issues, concepts and computer codes
- Extensive experience with SFRs
  - Na not a candidate for FPP, but general concepts of impurity control, etc. relevant to developing FPP with Li or Pb-Li
- Synergy with understanding additive manufacturing potential NPP/FPP