High Operating Temperature Liquid Metal Heat Transfer Fluids

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PROJECT OBJECTIVES

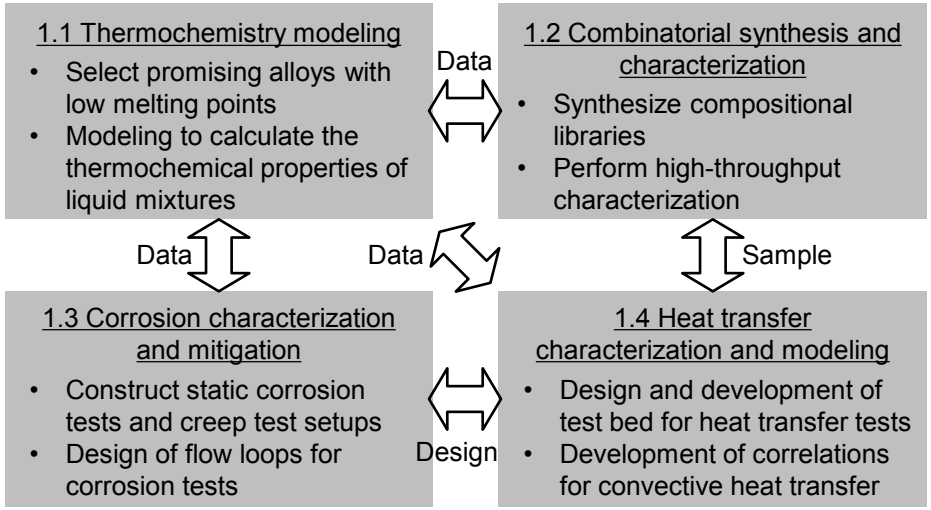
Goal: Develop liquid metals with thermophysical and corrosion properties suitable for use as high temperature (> 800 C) heat transfer fluids. Perform scaled flow loop tests to confirm the effective prevention/mitigation of corrosion and determine the convective heat transfer characteristics.

Innovation: This study employs the synergistic use of the combinatorial material synthesis and high-throughput characterization techniques together with advanced thermochemical modeling to efficiently explore vast compositional spaces.

Milestones:

- Identify at least 5 base alloys of distinctly different elemental compositions with melting points < 300 C
- Validate modeling accuracy to within 10% of the experimental values for melting point, density, and specific heat.
- Validate new static corrosion test setups with oxygen control to within 10% with the data in the existing literature.

APPROACH



KEY RESULTS AND OUTCOMES

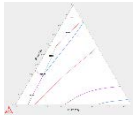
1.1 Thermochemistry modeling

1) Initiated CALPHAD calculations to identify candidate ternary alloy compositions with low eutectic temperatures

2) Initiated development of image-processing software for analysis of solid and liquid phase fractions in thin-film experiments

1.2 Combinatorial synthesis and characterization

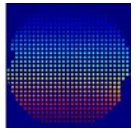
Determined the liquidus projection for Bi-Cu-Sn and Bi-Sn-Zn



1.3 Corrosion characterization and mitigation

1) Initiated validation of static corrosion and creep test setups

2) Performed preliminary corrosion tests in LBE



1.4 Heat transfer characterization and modeling

Initiated construction of a flow loop that will serve as a test bed and an intermediate HEX loop for later high temperature loops

NEXT MILESTONES

1.1 Thermochemistry modeling

- Continue CALPHAD based calculations to search for optimal ternary alloy compositions.
- Initiate development of liquid density models.

1.2 Combinatorial synthesis and characterization

- Pipe-Liquid interaction of compositional library
- More alloys, alloy additions and effect on liquidus temperatures
- Iteratively optimize the compositions.

1.3 Corrosion characterization and mitigation

- Tune static corrosion testing systems for testing over an extended period of time.
- Perform analysis of the micro mechanical testing on the oxide layers.

1.4 Heat transfer characterization and modeling

- Complete the construction of the flow loop and perform experiments to measure heat transfer characteristics.