Passive and compact liquid metal heat switch

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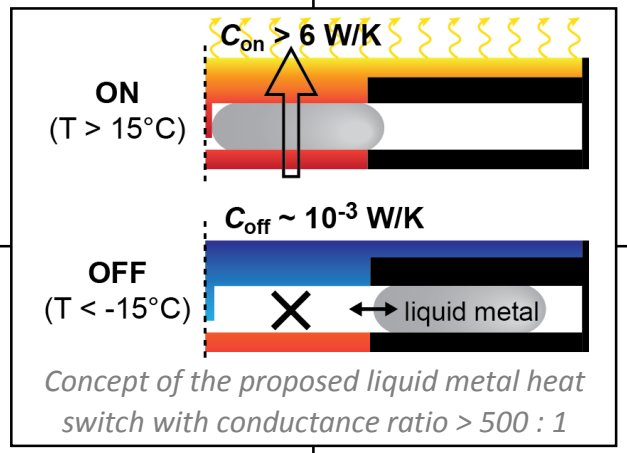
Research Objectives

- Current state-of-the-art heat switches are often bulky and complex, or have low ON/OFF switching ratios
- This heat switch is compact, light-weight, and passively controlled.
- Key performance metrics are: switching ratio > 500 : 1, mass < 100 g, thickness 2 – 7 mm, passive switching
- Currently TRL 2; first experiments show switching ratio 71 : 1
- Projected TRL 3/4; full feasibility analysis and first system integration



Concept of the proposed liquid metal heat switch with conductance ratio > 500 : 1

Approach

- Channel with thermally conducting and insulating sections
- A liquid metal plug (melting temperature -19 °C) moves within the channel to connect (ON) or disconnect (OFF) the two thermal conductors
- Passive actuation in a channel
- Detailed thermal analysis based on: a) applied constant heat flux, and b) constant environmental temperatures (equivalent to lunar environment -180 °C to + 130 °C)
- Integration with flexible thermal management materials (*e.g.*, thin rubber sheets)

Potential Impact

- Heat switches can manipulate the flow of thermal energy
- Passive regulation of spacecraft internal temperatures, irrespective of environmental conditions and at all stages of the mission
- Successful implementation of heat switches enables unprecedented human- and science-based missions of small and large spacecraft structures on the moon, on Mars, and in deep space
- Direct scientific impact in the area of dynamic liquid-structure interactions