



## NASA SBIR 2014 Phase I Solicitation

### H8.01 Solid Oxide Fuel Cells and Electrolyzers

Lead Center: GRC

Participating Center(s): JSC

Solid oxide technology for fuel cells and electrolyzers to enable:

- The operation of fuel cells using hydrocarbon reactants, including methane and ISRU-generated fuels.
- Electrolysis systems capable of electrolyzing CO<sub>2</sub> from the Mars atmosphere, and/or water from the Mars surface to generate oxygen, or to recover oxygen from CO<sub>2</sub> and water from crew respiration for life support.

Both component and system level technologies are of interest.

Technologies are sought that improve the durability, efficiency, and reliability of solid oxide fuel systems capable of internal reforming of hydrocarbon fuels. Hydrocarbon fuels of interest include methane and fuels generated by processing lunar and Mars soils. Primary solid oxide components and systems of interest are:

- Solid oxide cell, stack, materials and system development for operation on unreformed methane in designs scalable to 1 to 3 kW at maturity. There is a strong preference for high power density configurations, e.g., planar.
- Solid oxide cells and stacks must startup with a minimal amount of water and then be capable of sustained operation on pure methane.
- Development of hermetic sealing materials for ceramic to ceramic interconnect or ceramic to metal interconnect stacks capable of thermal cycling. Data for the proposed seals materials and sealing scheme/design should be included in the proposal.
- Development of catalysts for direct internal reforming of methane. Provide single cell performance data on dry methane for the one or more of the proposed anode compositions.

Proposed technologies should demonstrate the following characteristics:

- Systems are expected to operate as specified after at least 20 thermal cycles during Phase I and the heat up rate must be stated in the proposal.
- The developed systems are expected to operate as specified after at least 500 hours of steady state operation on propellant-grade methane and oxygen with 2500 hours expected of a mature system. System should startup "dry" or with a minimal amount of water, but after reaching operating conditions an amount of water/H<sub>2</sub> consistent with what can be obtained from anode recycle can be used. Amounts must be justified in the proposal.
- Minimal cooling required for power applications. Cooling in the final application will be provided by means of conduction through the stack to a radiator exposed to space and/or by anode exhaust flow.

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Research should be conducted to demonstrate technical feasibility during Phase I and show a path toward a Phase II hardware demonstration. Emphasis should be on demonstrating technical feasibility, prototype hardware (2-4 cell stacks preferred), conceptual designs and implementation approaches.