The purpose of In-Situ Resource Utilization (ISRU) is to harness and utilize resources (both natural and discarded material) at the site of exploration to create products and services which can enable and significantly reduce the mass, cost, and risk of near-term and long-term space exploration. The ability to make propellants, life support consumables, fuel cell reagents, and radiation shielding from in-situ resources can significantly reduce the cost, mass, and risk of sustained human activities beyond Earth. Since ISRU may be performed wherever resources exist, ISRU systems need to operate in a variety of environments and gravities. Also, because ISRU systems and operations have never been demonstrated before in missions, it is important that ISRU concepts and technologies be evaluated under relevant conditions (gravity, environment, and vacuum) as well as anchored through modeling to regolith/soil, atmosphere, and environmental conditions. While the discipline of ISRU can encompass a large variety of different concept areas, resources, and products, the ISRU Topic will focus on technologies and capabilities associated with atmospheric and trash/waste resource collection, transfer, and processing.

Subtopics

H1.01 In-Situ Resource Utilization
Lead Center: JSC
Participating Center(s): ARC, GRC, KSC
Converting in-situ resources into propellants, energy storage reactants, or other useful products at the site of exploration, known as in-situ resource utilization (ISRU), versus transporting from Earth can significantly reduce the cost and risk of human exploration while at the same time enabling new mission concepts and long term exploration sustainability. Potential in-situ resources of interest include extraterrestrial atmospheres, soils/regolith, and discarded mission materials such as trash (food, wipes, paper, etc.), packaging materials, and crew waste. Technologies and innovative approaches are sought related to the collection, transfer, and processing of these in-situ resources into intermediate (carbon monoxide/carbon dioxide, water, hydrogen, and hydrocarbons) and final products (methane and oxygen) for propulsion and energy generation applications. The subtopic seeks proposals for the design and subsequent building of synergistic hardware that can support Mars atmosphere capture and processing and mission trash/waste conversion. Technologies of interest include:

- Trash feed into high temperature reactors with tight cabin leakage specs.
- Trash gasification reactors (steam and/or partial oxidation) with minimum tar and ash generation and
subsequent tar/liquid hydrocarbon reduction.

- Highly efficient reactors for carbon monoxide/carbon dioxide (CO/CO$_2$) conversion into methane (CH$_4$).
- Highly efficient gas/gas and gas/liquid-vapor separation devices.
- Fine particle/gas separation (regenerative or continuous) technologies for Mars dust and gasification ash particles.

The proposed technology should address benefits in system mass, conversion and power efficiency, and intermediate/final product generation compared to current approaches. Proposed technologies need be able to operate in microgravity. Mars ISRU technologies need to involve separation and processing of 0.5 to 2 kg/hr of carbon dioxide. Trash processing technologies need to be capable of feeding and processing 12 kg of waste material per day.

Technology Readiness Levels (TRL) of 2 to 5 or higher are sought.

Potential NASA Customers include:

- Office of Chief Technologist/ISRU Program.
- Advanced Exploration Systems Logistics.
- Advanced Exploration Systems Mars Program.