

Maxi space exploration via mini technology

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Images of deep space exploration in old sci-fi movies will take one giant leap toward reality as Battelle scientists manipulate microtechnology to produce rocket propellant in space and breathing oxygen for interplanetary travel, thanks to new funding from NASA.

Scientists at Pacific Northwest National Laboratory in Richland, Wash., which is operated by Battelle for the Department of Energy, will launch the development of a lightweight and extraordinarily compact system for NASA applications. These microchemical and thermal systems, also known as MicroCATS, configure such things as microchannel absorbers, reactors, separators and heat exchangers to produce the propellant from resources found on Mars and the moon. In addition, the system also will be designed to regenerate breathable air for life support. The NASA contract is valued at \$13.7 million over four years.

"Further development of the microchannel architecture makes this all feasible," says Kriston Brooks, PNNL principal investigator. "Our ultimate goal is then to use the same microtechnology principles on a larger scale to provide propellant for a manned mission to Mars in the 2030 timeframe."

PNNL's mission supports the President's new vision for space exploration. President Bush pledged to return to the moon by 2020 in preparation for future human exploration of Mars and other distant destinations in his January 2004 address at NASA headquarters.

"The contract is four times larger than any PNNL has previously had with NASA," says Martin Kress, Battelle's NASA relationship manager.

"We hope this technology system ushers in an entirely new approach for lunar and Martian exploration and habitation," Kress added.

The compact microtechnology processing station, referred to as ISPP, the In Situ Propellant Production system, will collect carbon dioxide from the Martian atmosphere and have it react with hydrogen gas to produce methane fuel and oxygen forming the propellant for the return voyage. "Additionally, by collecting and reconditioning exhaled air, the system will produce pure oxygen for crew members; a problem that nearly doomed the Apollo 13 mission," noted Brooks. Both methane and oxygen also can be used to generate electrical power for vital life support systems making this capability central to a manned outer space infrastructure.

"Since the system uses modular banks of identical microchannel components, there is a built-in redundancy achieving enhanced safety and reliability," stated Brooks. "We anticipate increased system efficiency as well as improved economic benefits when the research is complete."

Microchannel technology generally has at least one dimension that is 200 microns or less in size – a human hair is about 20-50 microns. Due to improved heat and mass transfer rates, the microtechnology process can be intensified, resulting in significant size reductions over conventional hardware. At these small scales, hydrodynamic, surface, and interfacial forces dominate, allowing the devices to operate independent of gravity. Gravity independence and reduced size and weight make microtechnology an ideal candidate for many NASA applications.

"We also hope to demonstrate the concept of making use of resources found both on the moon and Mars, not only for propellant and breathing air, but ultimately to build a community in space," says Brooks. "For instance, silica, iron and titanium retrieved from soil on the moon could

be used to produce photovoltaics capable of generating electricity, and producing metals for building construction and other manufacturing processes." Brooks admits that these capabilities are still conceptual, but says that by demonstrating the next generation of microchannel technology for ISPP, researchers may be able to advance these capabilities as well.

The technology's system components will be tested individually, as well as in a combined integrated system in a single "bread-board" configuration. The analysis will be performed at NASA centers using an atmospheric chamber to simulate the low temperatures and extremely low atmospheric pressure typical of Mars and the moon, and using reduced gravity parabolic flights to simulate low gravity.

PNNL will coordinate parts of this research with Oregon State University via the Microproducts Breakthrough Institute. MBI is a collaboration between PNNL and OSU, and is affiliated with ONAMI, the Oregon Nanoscience and Microtechnology Institute.

Source: PNNL

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