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The Application of Self-Propagating High Temperature (Combustion) Synthesis (SHS) for In-Situ Fabrication and Repair (ISFR), and In-Situ Resource Utilization (ISRU)

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ABSTRACT

NASA has recently shifted its focus to emphasize space exploration. The need to fabricate and repair components in the space environment and to utilize the planetary mineral resources for fabrication and repair of components has become a vital part of this new initiative. SHS is being considered as one of these innovative technologies for both in-space fabrication and repair (ISFR), and in-situ resource utilization (ISRU).

The advantage of SHS for both ISFR and ISRU is that it can be used to synthesize, repair and join a wide range of advanced materials, fully dense or with controlled porosity (20-90%), in low vacuum, low and microgravity environments, and in oxygen–free or oxygenated (including CO_2) environments. As such, engineered SHS reaction systems can be designed to take advantage of the ambient environment, rendering an extremely high degree of process versatility and flexibility.

This paper will review the work that is currently being conducted by a joint research team from the Institute for Space Resources (ISR) at the Colorado School of Mines (CSM) and Guigné Space Systems, Inc. (GSSI), and funded by different NASA flight and research centers. The application of SHS to fabricate and repair a wide range of materials and components will be discussed with examples that include acoustic damping systems for rocket engines, joining of components, fabrication of structural components, and mineral sterilization. In particular, the application of this technology for in-space fabrication and repair and in-situ resource utilization will be highlighted, as will the effects of gravity on the SHS process and products. Finally, we will take a look towards future applications such as drug delivery systems for astronauts undertaking long-term space missions.