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Self-Propagating High-Temperature Synthesis of Al-Ti-B in the ISS: Reactor Design and Preliminary Evaluation

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ABSTRACT

Within the framework of the European Space Agency (ESA)-coordinated project Combustion Synthesis under Microgravity Conditions (COSMIC), a microgravity experiment on the International Space Station (ISS) has been performed during the Belgian taxi-flight (BTF) Mission Odissea in November 2002. The experiment's main objective was to investigate the relationship between the general physicochemical mechanisms of the combustion process and the formation of the microstructure. Within the combustion zone, a number of gravity-dependent phenomena occur while other phenomena are masked by gravity. Under certain conditions, gravity-dependent secondary processes may also take place in the heat-affected zone after combustion.

To study the influence of gravity, a specially dedicated reactor ensemble has been designed and was used in the Microgravity Science Glovebox (MSG) onboard the ISS. First, the experiment design is discussed in terms of its functionality and its integration in the MSG. The consequences of this integration and its design are compared with ground performance of the experiment. To study the microstructure formation, a sample constituted of a cylindrical portion followed by a conical one, the latter being inserted inside a massive copper block, has been used.

The experiment focused on the production of intermetallic matrix composites based on the Al-Ti-B system. Depending on the composition, different intermetallic compounds can be formed: TiAl, Ti_3Al and $TiAl_3$ as the matrix phase and TiB_2 as the reinforcing particulate phase. During the ISS mission, six samples with a relatively high green density of 65%TD have been successfully processed. The influence of the composition on the combustion process will be examined.