

## **Additively Manufactured Combustion Devices Components for LOX/Methane Applications**

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Marshall Space Flight Center (MSFC) has designed, fabricated, and hot-fire tested a variety of successful injectors, chambers, and igniters for potential liquid oxygen (LOX) and methane (CH<sub>4</sub>) systems since 2005. The most recent efforts have focused on components with additive manufacturing (AM) to include unique design features, minimize joints, and reduce final machining efforts. Inconel and copper alloys have been used with AM processes to produce a swirl coaxial injector and multiple methane cooled thrust chambers. The initial chambers included unique thermocouple ports for measuring local coolant channel temperatures along the length of the chamber. Results from hot-fire testing were used to anchor thermal models and generate a regeneratively cooled thruster for a 4,000 lbf LOX/CH<sub>4</sub> engine. The completed thruster will be hot-fire tested in the summer of 2016 at MSFC. The thruster design can also be easily scaled and used on a 25,000 lbf engine. To further support the larger engine design, an AM gas generator injector has been designed. Hot-fire testing on this injector is planned for the summer of 2016 at MSFC.

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