Phase I Project Summary

Research Objective:

The performance liquid propellant engines can be significantly improved by increasing both combustion temperature and pressure and reducing engine weight. State of the art Bi-propellant engines are metallic; the highest temperature combustion chambers are made of iridium/rhenium metals. Utilizing carbon-carbon composites for thrust chamber structures can reduce component weight by as much as 90%. Unfortunately carbon composites suffer from unacceptably high oxidation rates. Lining carbon-carbon chambers with a thin layer of iridium or iridium/rhenium is an innovative way to provide the oxidation barrier necessary to enable the use of carbon-carbon composites. This effort evaluated using metal-lined carbon-carbon to produce high pressure, light-weight thrust chambers.

Research Performed:

An innovative high-pressure, light-weight combustion chamber was designed with leading bipropellant propulsion system manufacturer, Aerojet (Redmond, WA). Dense, uniform iridium liners were electrodeposited onto complex shaped thrust chamber mandrels.. Carbon/carbon composite structures were braided over the iridium lined mandrels and densified by chemical vapor infiltration. Niobium deposition was evaluated for forming a metallic attachment flange on the carbon/carbon structure. A light-weight thrust chamber was produced.

Research Results:

1. A high pressure bi-propellant thrust chamber was designed and manufactured with lightweight materials to the dimensions of NASA/Aerojet's Advanced Material Bi-Propellant Rocket (AMBR), an engine with an Isp of 333.5 seconds.

2. A carbon/carbon braided chamber was developed and manufactured over the same type of iridium liner used in state-of-the-art bi-propellant engines and AMBR.

3. A niobium flange was deposited on the carbon/carbon structure.

4. Weight savings of 67% were demonstrated using the SBIR technology compared to the AMBR combustion chamber.

Phase II Justification:

The SBIR Phase I demonstrated design and fabrication of a Bi-propellant rocket with a 67% weight savings as compared to the current state-of-the-art AMBR chamber. Design optimization is required which will lead to even higher weight savings. Phase II hot fire testing is required to determine life and performance and to increase the TRL to 5-6.