

【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering II)



Title of Project : HyperMixer Scramjet Engine for Wide Flight Mach Number Range

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Research Area : Aerospace engineering

Keyword : Scramjet Engine, HyperMixer, Streamwise Vortices, Hypersonic Vehicle, Space Launcher

【Purpose and Background of the Research】

To build hypersonic airbreathing vehicles capable of flying as fast as rockets in a wide range of flight Mach numbers, 4-15 is indispensable for our continued space development and utilization. This breakthrough is expected to be made by 'Scramjet' (Supersonic Combustion Ramjet), an engine that intakes hypersonic air flow, mixes the air with fuel and performs efficient combustion at supersonic speeds to generate the necessary massive thrust.

For this end the present research project proposes to develop what we call HyperMixer Scramjet characterized by efficient air-intake and HyperMixer fuel injectors which generate streamwise vortices to enhance the supersonic mixing and combustion and to suppress the combustor boundary layer separation (Figure 1). This project consists of the following researches:

- (A) Further development of key technologies and knowledge for HyperMixer Scramjet
- (B) Design of engine elements and system, and manufacturing of a prototype engine
- (C) Performance evaluation of the prototype

【Research Methods】

This project is conducted by people from Japan Aerospace Agency (JAXA), Osaka Prefecture Univ., Tohoku Univ. and Keio Univ., with having research cooperation with DLR (Germany) and ONERA (France). We will also make an effort to grow young researchers and graduate students.

The item (A) research focuses on fundamental key technologies of the intake and the supersonic combustor which critically govern the scramjet performance. We have to develop the design and performance evaluation tools for the intake. For the combustor we have to much improve our understanding of the mechanism of supersonic mixing and combustion process to maximize the thrust by using streamwise vortices for mixing/combustion enhancement as well as for the boundary layer control. In the item (B) research we will design a prototype HyperMixer scramjet engine for wide flight Mach number range on the basis of the knowledge and technologies obtained in the item (A) research. In the item (C) research the prototype engine is model-tested and evaluated its performance by using the High Enthalpy Shock Tunnel and CFD. The result will be feed-backed to the item (A) and (B) researches. This process will be repeated twice.

【Expected Research Achievements and Scientific Significance】

The proposed wide Mach number range scramjet is really revolutionary and has not yet been achieved in the world. In this project, we will develop a prototype of wide Mach number range HyperMixer Scramjet of our original design, and evaluate its performance. The scramjet engine, if realized, will enable us to develop hypersonic airbreathing vehicle and space launcher systems, more enhancing mission flexibility by combining with other engines such as turbojet and rocket. This revolutionary change in propulsion should make profound ripple effects on the various aspects of human activities, lives and cultures.

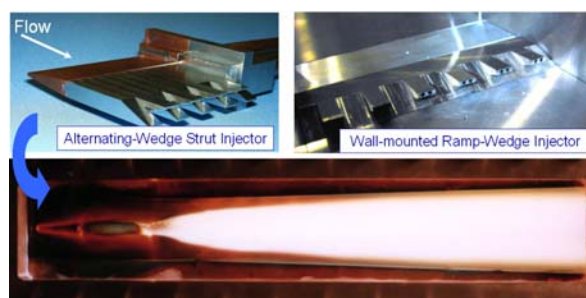


Figure 1 HyperMixer injectors and Flame of supersonic combustion with the AW Strut

【Publications Relevant to the Project】

- Sunami, T., Wendt, M. N. and Nishioka, M., "Supersonic Mixing and Combustion Control Using Streamwise Vortices," AIAA Paper 98-3271, 1998.
- Sunami, T., Murakami, A., Kudo, K., Kodera, M., Nishioka, M., "Mixing and Combustion Control Strategies for Efficient Scramjet Operation in Wide Range of Flight Mach Numbers," AIAA 2002-5116, 2002.
- Sunami, T., Itoh, K., Sato, K., Komuro, T., "Mach 8 Ground Tests of the Hypermixer Scramjet for HyShot-IV Flight Experiment," AIAA 2006-8062, 2006.

【Term of Project】

FY2009-2013

【Budget Allocation】

116,800 Thousand Yen

【Homepage Address and Other Contact Information】

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