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

Title of Project : Fly By Light Power: Improvement in High-Speed Aerodynamics with Low-Power Deposition

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Research Area : Aerospace Engineering

Keyword : Aerospace Fluid Dynamics, Shock Waves, Plasma, Laser

【Purpose and Background of the Research】

Supersonic flight over residential land has not been commercialized due to poor lift to drag ratio, L/D, and serious sonic boom. This project aims in developing a new methodology to overcome the above problems with lower average power deposition supplied as repetitive laser pulses.

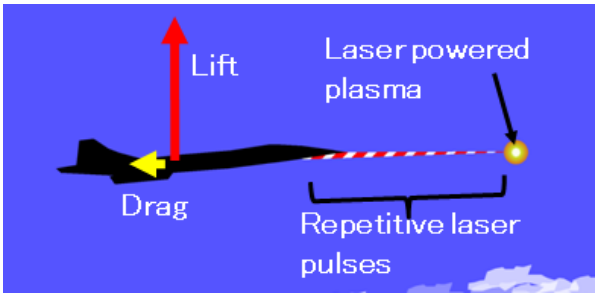

Figure 1 Increasing lift-to-drag ratio with repetitive laser pulses

【Research Methods】

In the beginning stage, the following five subjects will be studied:

(1) The laser-powered plasmas will form a column which influences the pressure field forward to the upstream, thereby decreasing the drag (precursory effects). Moreover, the L/D will be increased with asymmetrical laser pulse depositions.
(2) Electromagnetic force will be applied to boundary layers over a body, thereby further improving the aerodynamics performance from the effective combination with the laser pulse depositions.
(3) The residence time and impulse will be increased due to the 'baroclinic effect,' which results from the interaction between a laser-induced plasma and a shock layer.
(4) Sonic boom will be alleviated with the 'active' control using laser pulse depositions, in which density and/or velocity fluctuations will remotely be generated.
(5) The conditions of energy depositions will be optimized.

The above-listed subjects and integrations at the later stage will be conducted utilizing shock tubes, supersonic wind tunnel, square-bore ballistic range, low-turbulence wind tunnel, repetitive pulse lasers, pulse discharge devices, and diagnostics tools including three-dimensional computational fluid dynamics.

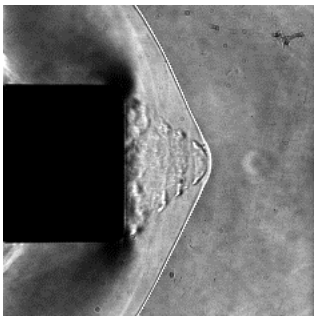

Figure 2 Experimental visualization of shock layer with repetitive laser pulse depositions.

【Expected Research Achievements and Scientific Significance】

This study will increase the feasibility of commercial supersonic transportation, and promote for its realization. High-power, high-efficiency and light-weight laser devices are expected to be available shortly for the technology of 'Fly by Light Power.' The present approach of vastly moderating flows with low average power deposition will establish a new methodology in high-speed fluid dynamics.

【Publications Relevant to the Project】

A. Sasoh, T. Ohtani and K. Mori, "Pressure effect in a shock-wave-plasma interaction induced by a focused laser pulse," Phys. Rev. Lett., 97, 205004, 2006.
T. Sakai, "Supersonic Drag Performance of Truncated Cones With Repetitive Energy Depositions," Intl. J. of Aerospace Innovation, Vol.1, No.1, pp.31-43, 2009.

【Term of Project】 FY2010-2014

【Budget Allocation】 172,100 Thousand Yen

【 Homepage Address and Other Contact Information】

http://akagi.nuae.nagoya-u.ac.jp/