

Hypersonic Propulsion and Supersonic Combustion: Review on Current Status for the Future

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Abstract

Remarkable advances in powered hypersonic flight have been achieved during last decade. A number of successful flight tests were carried out successfully those made the dreams of last 50 years come true. The successful flight test of X-51A last year opened new era of powered hypersonic flight for practical applications. Propulsion technologies of X-51A is distinguished by dual-mode ramjet (DMR) engine which starts at ramjet mode and transit to scramjet mode accelerating from supersonic launch speed and to hypersonic cruising condition. One of the important technical advances in the DMR engine is the sophisticated handling of endothermic liquid fuel for the regenerative cooling and adaptive combustion control for the operation condition from starting to cruising. The technology will be succeeded to the combined cycle engines including TBCC(Turbine-Based Combined Cycle) and RBCC(Turbine-Based Combined Cycle) engines for large reusable systems or more affordable small systems.

The sophisticated technology levels of today is thoroughly based on the scientific achievements from the experiments and analyses carried out concurrently, and the future advances depends it. Present review will address the current status and future directions in the researches and developments in hypersonic propulsion and its scientific aspects in supersonic combustion. The first half of the review will summarize the hypersonic propulsion and supersonic combustion test programs during the past and near future. International activities on ground and flight test programs will be introduced with emphasis on supersonic combustion technologies.

The second half of this review will cover the supersonic combustion technologies and physics newly understood from the recent researches. It will include the fuel issues from hydrogen to liquid hydrocarbon fuels. Handling properties of fuels, fuel injection schemes and combustion characteristics of the fuels will be discussed in this regards. Another important issue is the flame structures, combustion dynamics and stabilities. Lessons learned from the recent experimental and analytics studies will be introduced with design aspects of the supersonic combustor. Research approaches including laser diagnostics and CFD techniques with modeling issues will be also discussed with some suggestions for future directions.