Preface

The focus in utilizing detonation for air-breathing propulsion has moved from the long-term studies of fuel energy transformation in stabilized oblique detonation waves to investigations and practical development of propulsion engines operating on propagating detonations in a pulse mode. Contrary to the oblique-detonation concept that is applicable to hypersonic flight at velocities comparable or higher than the Chapman–Jouguet detonation velocity of the fuel–air mixture, the concept of a pulse detonation engine (PDE) is attractive for both subsonic and supersonic flight, with a PDE as the main propulsion unit or as an afterburner in turbojet or turbofan propulsion systems. In particular, PDE-based propulsion is attractive for flight Mach number up to about 3–4. Within this range of Mach number, solid rocket motors are known to be very efficient in terms of simplicity and high-speed capability, but they have a limited power range. Turbojet and turbofan engines, due to their high specific impulse, provide longer range and heavier payloads, but at flight Mach numbers exceeding 2–3, they get very expensive. Ramjets and ducted rockets designed for flight Mach numbers up to 4 require solid rocket boosters to accelerate them to the ramjet takeover speed, which increases the complexity and volume of a propulsion system. Combined-cycle engines, such as turborockets or turboramjets, are also very complex and expensive for similar applications.

In a PDE, detonation is initiated in a tube that serves as the combustor. The detonation wave rapidly traverses the chamber resulting in a nearly constant-volume heat addition process that produces a high pressure in the combustor and provides the thrust. The operation of multitube PDE configurations at high detonation-initiation frequency (about 100 Hz and over) can produce a near-constant thrust. In general, the near-constant volume operational cycle of a PDE provides a higher thermodynamic efficiency as compared to the conventional constant-pressure (Brayton) cycle used in gas turbines and ramjets. The advantages of PDE for air-breathing propulsion are simplicity and easy scaling, reduced fuel consumption, and intrinsic capability of operation from zero approach stream velocity to high supersonic flight speeds.

During the period from 1998 to 2004, the U.S. Office of Naval Research* (ONR) and the Russian Foundation for Basic Research (RFBR) have jointly sponsored four International colloquia on detonations, in particular, those aspects of detonations that are directly relevant to the development of PDEs. In 1998, the International Colloquium on Advances in Experimentation and Computation of Detonations was held in St. Petersburg with the participation of more than 60 experts. In 2000, the International Colloquium on Control of Detonation Processes was organized in Moscow with more than 100 participants. The International Colloquium on Advances in Confined Detonations was held in Moscow in 2002 with more than 120 participants. As a result of these meetings, a number of books have been published containing revised and edited extended abstracts of all presentations and full edited manuscripts of selected papers presented at the colloquia. Finally, in 2004, the International Colloquium on Application of Detonation for Propulsion has been organized in St. Petersburg. Again, the international scientific community responded enthusiastically with 50 papers from 12 countries.

Similar to our efforts with all previous colloquia, we have endeavored to revise, thoroughly edit, and publish in this volume the condensed versions (extended abstracts) of the papers presented at the Colloquium-2004. The material in the volume is subdivided into four topical sections according to the technical program of the Colloquium:

(1) Fundamentals of Gaseous Deflagrations and Detonations;

(2) Fundamentals of Heterogeneous Detonations;

(3) Continuous Detonation Propulsion; and

(4) Intermittent Detonation Propulsion.

This book provides an overview of the state-of-the-art in gaseous and heterogeneous detonations and their application to propulsion. Extended up-to-date references as well as authors' affiliations are added so that further information can be readily obtained. To make reading more convenient, an author index is provided at the end of this

*The content of the information does not necessarily reflect the position or the policy of the United States Government and no official endorsement should be inferred.

book. The volume is prepared as a reference for practicing engineers, research scientists working in the field of combustion and propulsion, and graduate students studying the corresponding disciplines.

The Colloquium and this volume are the outcome of hard work of several persons, and we highly appreciate their valuable contributions. In particular, we acknowledge the assistance given at various stages by Ms. Olga Frolova. We thank the staff of TORUS PRESS Publishers for their excellent service in producing the volume and organizing the conference.

Special thanks are due to Academician A. A. Berlin, Academician A.G. Merzhanov, and Prof. S.A. Tsyganov for their valuable contribution to the organization of the Colloquium. We thank the authors for their time and effort in preparing their papers and participation in the Colloquium and the sponsoring agencies for their financial support, without which this endeavor would not be possible. We do hope that this volume will serve as a useful addition to the literature on detonation and propulsion.

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