INTRODUCTION

Almost a century ago, in 1899, Chapman provided a theoretical estimate for the detonation velocity based on one-dimensional flow considerations and compared it with experimental data. Since then, significant progress has been made both in the experimentation and computation of detonations. This international Colloquium is organized to provide a forum to assess the state-of-the-art and a means to disseminate this information to the international scientific community.

Although the study of detonation phenomena has been active during the past century, the application of detonations for non-destructive purposes, such as propulsion, drilling, pressing, protective coating, etc., has been studied only in the past few decades. It is hoped that recent advances, captured in this volume, will provide an additional impetus for the application of detonations for propulsion. With this point of view, though the topics covered in the Colloquium emphasize basic understanding of detonation initiation, structure, propagation, mitigation, and control, it is anticipated that the discussions will focus towards making use of this basic understanding of detonations for applications to propulsion.

The book includes 75 contributions addressing various aspects of detonation physics and chemistry, submitted by researchers from Algeria, Belgium, Canada, France, Germany, Japan, Poland, Russia, Ukraine, United Kingdom, and the United States of America. Of the papers selected for oral and poster presentations, thirty eight (38) papers provide new information gained from experiments, and out of these nine (9) include theoretical models of the phenomena under study. The remaining thirty seven (37) papers are purely theoretical or computational and provide additional information on advances in the physics and applications of detonations. From the response of researchers, there seems to be a balance in the experimental and computational studies carried out.

Section **Detonation Initiation** includes contributions on the most challenging problem in detonation physics. Experimental and theoretical studies on initiation of gaseous and heterogeneous detonations are presented. The issues addressed are the critical energy of detonation initiation (Borisov, Vasil'ev et al., Vidal and Khasainov, Wilson et al.), deflagration-to-detonation transition (DDT) (Borisov, Smirnov et al., Subbotin, Ilyin and Abrukov), enhancement of DDT (Borisov, Rose et al., Wilson et al., Subbotin, Bartenev et al., Gelfand et al.), transition of confined detonations into unconfined ambience (Borisov, Manzhaley), detonation initiation in suspensions of high explosives (HE) in air (Grigor'ev et al.) and vacuum (Zhdan and Prokhorov), and the use of advanced algorithms for computing transient flows with non-reactive and reactive shock waves (Rose et al., Smirnov et al., Gehmeyr, Bartenev et al.). Wilson et al. and Smirnov et al. discuss the applicability of various concepts of detonation initiation to Pulsed Detonation Engines (PDE) and Pulse Detonation Generators, respectively.

Section **Detonation Wave Structure and Propagation** includes contributions on experimental and theoretical studies of detonation structure and propagation mechanisms in gaseous and heterogeneous media. The issues addressed are the multi-dimensional structure of self-sustaining gaseous detonation fronts (Oran, Hanana et al., Hayashi, Sharypov, Rybanin, Trotsyuk, Gvozdeva and Scherbak), transition from regular to irregular cellular patterns (Sharypov, Rybanin), detonation cell structure and size (Oran, Hanana et al., Nikolic et al., Hayashi, Gavrikov et al.), structure of self-accelerating flames (Gostintsev et al.), oblique detonation wave structure and stability (Viguier and Desbordes), gaseous detonation propagation and structure in tubes of variable cross section (Baklanov et al.), anomalous phenomena in shock–plasma interactions (Basargin and Bedin), and the propagation and structure of combustion and detonation waves in porous media (Korzhavin et al., Pinaev). Baklanov et al. discuss the advantages of their approach for utilization in practical applications, such as propulsion devices.

Presented in Section **Detonation Mitigation and Control** are the contributions on experimental and theoretical aspects of gaseous and heterogeneous detonation control by various means, namely, by changing composition and density of the reactive mixture (Mitrofanov, Auffret et al., Khadyev and Starikovskii, Sychev), by obstructions and wall inflections (Mitrofanov, Fisher et al., Gelfand et al., Kopchenov et al., Galburt and Ivanov), by preliminary vibrational excitation of reactive mixture (Starik and Titova), and by electrical discharge (Afanas'ev et al.). Also addressed are the fundamental issues dealing with stability of a planar detonation wave (Williams), detonability limits (Aslanov and Lubchenko, Sychev), the effect of combustion generated pressure waves on turbulence (Luo), geometrical scaling of flame acceleration and DDT in obstructed ducts (Kuznetsov et al.), controlling pre-detonation distances during DDT (Sumskoi and Borisov), and deflagration and detonation analogies in superheated liquids (Ivashnev et al.). In a number of papers, the applications of various detonation controlling strategies to practical facilities are discussed. In particular, Mitrofanov considers such applications as non-electric means for explosion initiation, and controlled detonation of propellants in power plants and jet engines, Kopchenov et al. discuss controlling strategies in scramjets with detonation combustion and ram accelerators.

Section **Applications of Detonation Phenomena** deals with contributions on detonation applications in propulsion (Zitoun et al., Cambier, Levin et al., Kailasanath, Berlyand and Vlasenko), transportation (Korobeinikov et al.), power engineering (Chereshnev et al.), safety engineering (Klemens et al., Zhukov et al.), and processing technology (Baklanov and Gvozdeva, Diachkin and Rybakov). Propulsion applications are focussed towards PDE (Zitoun et al., Cambier, Levin et al.) and ram accelerators (Kailasanath). Korobeinikov et al. consider an internal combustion engine with electrochemical pulse jet ignition followed by detonative combustion. The use of electro-physical properties of detonation products in explosive fast opening switches is suggested by Chereshnev et al. for fast (microsecond duration) energy transmission from explosive magnetic generators to a load. Klemens et al. study the mechanisms of dust explosions in coal mines required for safety regulations. Baklanov and Gvozdeva study the peculiarities of detonation assisted surface depositing of protective coatings based on aluminum oxides. Diachkin and Rybakov investigate explosion pressing of metal powder for obtaining specimens with desired properties.

Section **Detonability of Advanced Fuels** deals with theoretical and experimental studies of detonation properties of various gaseous, heterogeneous, and solid fuels. Detonation of dispersed aluminum in oxygen and/or air is studied by Ingignoli et al., Fedorov et al., Victorov et al., while Imkhovik and Solov'ev consider oxidation of aluminum particles in detonation products of HMX, RDX, TNT, etc. Frolov et al. report a semi-empirical oxidation mechanism of heavy hydrocarbon fuels — prospective candidates for applications in PDE. Jet combustion of hydrogen as a prospective fuel for propulsion devices is studied by Baev et al. Azatyan et al. study the effect of gas-phase inhibitors on hydrogen–air detonations. Fomin et al. report a model of hydrogen combustion in a bubble detonation wave. DDT and the mechanisms of convective burning and low-velocity detonations in porous propellants are studied by Sulimov and Ermolaev, Ischenko and Khomenko, and Imkhovik et al. Mitrofanov and Subbotin report the results of experiments on detonation of deposits of HE (lead azide, PETN, RDX) particles in evacuated tubes, and Zhdan and Prokhorov suggest a theory of detonation of RDX particle suspensions in ducts. Detonability of liquid explosives such as nitrobenzene and propynol is studied by Kozak and Kondrikov, and hydrazine by Voskoboinikov and Victorov et al. Another contribution by Victorov et al. presents thermodynamic calculations of detonation parameters of n-propylnitrate, nitromethane and a number of other fuels. Experimental techniques for determining burning and gas formation laws in condensed systems are described by Khomenko et al. Abrukov and Ilyin analyze various optical methods for detonation studies.

It is evident that a great deal of research is going on around the world focussing on this interesting phenomenon — detonation. It is our sincere hope that this book will help in formulating a dialogue among the members of the research community.

Editors