

### **SOLID BASIS FOR “SOLID FLAME”**

From 28 to 30 November, 2016 the city of Chernogolovka (Moscow region, Russia) hosted the 3rd International Conference "Nonisothermal Phenomena and Processes: from Thermal Explosion Theory to Structural Macrokinetics» (NPP-2016) dedicated to the 85th anniversary of the birth of Academician Alexander G. Merzhanov – a renowned scientist, co-discoverer of self-propagating high temperature synthesis (SHS). The Conference was organized by the Institute of Structural Macrokinetics and Materials Science (ISMAN) RAS and Scientific Center RAS in Chernogolovka.

The Conference has its origins in Yerevan, where Academician A.G. Merzhanov was invited on the eve of his 75th birthday in 2006 by the National Academy of Sciences of the Republic of Armenia. A.G. Merzhanov offered a nontrivial conference name. He intended to emphasize the origins of the SHS, to show that the patterns found in the study of combustion and explosion processes are applicable to a wide range of nonisothermal processes in chemistry and mechanics.

The 2nd Conference was held in 2011 in Chernogolovka in a spacious building of the newly built Research and Education Centre (REC) of ISMAN. The choice of the venue was quite natural, as for many years ISMAN had been led by its founder A.G. Merzhanov.

In connection with the death of Academician A.G. Merzhanov in 2013, for the first time the Conference NPP-2016 was held without its founder. It was dedicated to the memory of the outstanding Soviet and Russian scientist, a wonderful person Alexander G. Merzhanov.

The NPP-2016 was attended by over 100 specialists from Russia, Belarus, Kazakhstan, Poland, the Czech Republic, Turkey, the USA and Japan. The geography of Russian participants significantly expanded and in addition to Chernogolovka included Moscow, Samara, Penza, Novosibirsk, Tomsk, Barnaul, Khanty-Mansiysk, Apatity, Grozny, Vladivostok, that certainly pleased the organizers of the Conference and all the followers of A.G. Merzhanov.

The Conference was opened by Director of ISMAN, Corresponding Member of RAS, Prof. M.I. Alimov, who welcomed the participants and honored guests and stressed the importance of the event. A speech with a brief recollection of an old friend and colleague A.G. Merzhanov was made by the President of Science Centre of RAS, Academician A.L. Buchachenko. The words of gratitude and respect to the memory of Academician A. Merzhanov were said by Professor E.A. Levashov (MISA, Moscow), Director of the Combustion Institute Professor Z.A. Mansurov (Almaty, Kazakhstan), followed by a welcoming speech of Director of the Institute of Precision Mechanics (IMP) (Warsaw, Poland) Professor Tomasz Babul, Professor of Istanbul Technical University (ITU) Onuralp Yucel and others.

The scientific program was opened by Director of ISMAN, Prof. M.I. Alimov whose report was dedicated to the review of the latest achievements obtained by the research teams of the Institute. An extensive overview report was presented by Professor I.P. Borovinskaya – a co-author of the discovery of “solid flame” (by A.G. Merzhanov, I.P. Borovinskaya and V.M. Shkiro), a comrade-in-arms in work and life of Academician Merzhanov. In her report at the Conference Inna Petrovna made a special emphasis on the broad capabilities of morphology and particle size control during the synthesis of ceramic materials in the combustion mode.

It should be noted that the topics of the reports presented at the Conference were diverse and included such areas as: theoretical and experimental studies of gases combustion (the reports by V.V. Azatyan, O.V. Skrebkov, A.V. Nikitin, V.S. Arutyunov, etc.); ignition and combustion of condensed materials (the reports by V.E. Zarko, A.P. Aldushin, P.M. Krishenik, V.A. Kudinov, I.G. Assovsky, etc.); filtration combustion (the reports by I.P. Borovinskaya, V.M. Kislov, M.V. Salganskaya, etc.); combustion of liquid phase systems (the reports by V.I. Yukhvid, K.G. Shkadinsky, etc.); combustion from solutions (the reports

by A.V. Hubarevich, Z.A. Mansurov, S. Roslyakov, etc.); the study of catalytic processes and materials (the reports by V.N. Borshch, Z.R. Ismagilova, etc.); the study of diffusion processes in solids (the report by S.P. Kiselev); the registration of emission phenomena in combustion (the report by A.I. Kirdyashkin); the visualization of combustion processes (the report by P.Y. Gulyaev), detonation coating processes (the report by Prof. Tomasz Babul) and many other interesting reports.

Traditionally, a considerable part of oral and poster presentations were devoted to the study of physico-chemical processes occurring in the synthesis of materials by means of SHS, which is not surprising since it is the discovery of “solid flame” that became a basis and then gave a powerful impetus to the development of broad theoretical and experimental research in a new field – structural macrokinetics of SHS-processes.

The reports had different formats. The reports summarizing numerous studies in the whole areas of SHS were presented by Prof. V.I. Yuxhvid (SHS-metallurgy), Prof. A.M. Stolin (SHS-extrusion), Prof. A.P. Amosov (SHS nitrides – azide technology). A survey report on the results of multi-year research on finding and testing various chemical schemes for synthesis of ceramic materials of complex composition by SHS-methods was presented by Prof. E.A. Levashov.

The analysis of the papers representing the latest achievements of specific technologies for producing new materials by SHS-methods revealed broad cooperation of the Institutes of Russian Academy of Sciences (ISMAN, the Institute of Chemical Physics, the Institute of Problems of Chemical Physics, the Institute of Solid State Physics, the Institute of Chemistry and Technology of Rare Elements and Mineral Raw Materials of Kola Scientific Center, RAS, the Institute of Strength Physics and Materials Science, the Institute of Catalysis named after G.K. Boreskov, RAS, etc.) as well as universities – both Russian (MISA, Samara State Technical University, Samara State Aerospace University, Tomsk Polytechnic University, Altai State Technical University named after Polzunov. et al.) and foreign ones (University of Notre Dame (USA), Istanbul Technical University (Turkey), Yerevan State University (Armenia), Institute of Precision Mechanics (Poland)).

Such integration is certainly fruitful and contributes to solving important scientific and technical problems. This fact was emphasized in a number of speeches which aroused a great interest among the participants. Among them are the reports by: V.N. Sanin, D. Tech. Sc., aimed at solving the problems of obtaining raw materials by SHS-methods for additive technologies, O.L. Pervukhina, PhD, on the development of a composite multilayer material promising in terms of vehicles armoring, E.A. Salgansky, D. Sc. (Phys.-Math.), on the results of the studies aimed at efficient combustion (recycling) of high-ash and high-moisture fuels on the basis of raw coal, V.A. Shcherbakov, D. Sc. (Phys.-Math.), on the synthesis of tungsten-free hard alloys based on  $ZrB_2$ -CrB and so on. The general conclusion is that at the present on the basis of such cooperation a number of new resource-efficient and energy-saving technologies have been developed for producing a large number of materials and finished products, including powders of refractory compounds, abrasive pastes, ceramics, parts and products of desired sizes and shapes, including tungsten-free hard alloys (cutting blades, rolls, electrodes, etc.), refractory products and coatings, complex-doped cast alloys, materials and protective coatings technology.

Of particular interest was the presentation made by M.H. Ziatdinov, PhD, from Tomsk State University, in which the author analyzed multi-year practical research aimed at introducing SHS-technology into the production of master alloys with a high content of nitrogen-containing compounds, which are now particularly in demand for producing azotized stainless steels. For the first time large-tonnage production was set up, and what is especially pleasant, it was realized on the territory of Russia – in Magnitogorsk. The results of implementation allowed developing new steel grades that can operate in arctic conditions, aggressive chemical environment, etc. The products of the company are supplied to all the modern metallurgical enterprises of our country. In addition, they are exported to Korea, China and Japan.

Of no less interest was the session of “theoreticians” held on the second day of the Conference. The chairman of the session S.M. Frolov hardly followed the established time-limit, since all the reports evoked a strong response among the colleagues and further discussion. Especially active were the professors V.E. Zarko, K.G. Shkadinsky, A.P. Aldushin, B.S. Seplyarsky.

It was a pleasure that the Conference was attended by many young scientists which means that A.G. Merzhanov’s life-work is developing successfully, despite objective difficulties. The scientific papers

of young researchers were so interesting that the NPP-2016 Organizing Committee decided to award the best speakers with diplomas. The honorary diplomas were awarded to young participants from Japan, the USA, Belarus and, of course, Russia – Moscow, Chernogolovka, Tomsk.

All the participants of the Conference noted that 3 days had passed quickly, “in one breath”. At the closing ceremony, which was conducted by Director of ISMAN there was a queue of scientists wishing to thank the organizers for the warm and friendly atmosphere during the Conference, for the opportunity to meet, communicate and to designate new research horizons.

But even after the official closing of the Conference the intercourse continued. The guests were invited to visit the Military Technical Museum in the village of Ivanovo, located near Chernogolovka. The museum exhibition devoted to the history of civil and military hardware is truly unique and did not left anyone indifferent. Thus, Prof. Z.A. Mansurov seeing examples of machines, on which in World War II his father had fought, was deeply touched and grateful for the opportunity to witness the historical machines. Professor from Turkey Onuralp Yücel was so concerned by what he saw that he offered to think about the organization of specialized tourist excursions at the international level. In addition to visiting the museum exhibits visitors were given the opportunity to drive an armored car and ride in a sleigh drawn by a surprisingly beautiful gray horse, visit the tent of military field kitchen and warm up by a cast-iron stove. At the end of the tour, all the participants noted that they had experienced a lot of positive emotions, some of which we hope they took away with them.

In conclusion, it should be noted that the event could not have been organized without the help and support of the Russian Foundation for Basic Research, Department of Chemistry and Materials Science of RAS. NPP-2016 was also supported by its partner – the Fund for Infrastructure and Educational Programs RUSNANO (FIEP RUSNANO), whose representative in the person of D.A. Filippov took part in the Conference. The invaluable support and assistance in registration of partner relations between FIEP and the Organizing Committee of the Conference was given by Chief Specialist of the Board for relations with authorities of FIEP M.V. Voronova.

The main conclusion of the Conference is that the life-work of Academician A.G. Merzhanov persists, research is ongoing, technologies are developing, and hence, in five years the Conference marking the 90th anniversary of A. Merzhanov will again gather his followers from Russia and other countries of the world.

***V.N. Sanin***

*Deputy Director of ISMAN for Research Work,  
Doctor of Technical Sciences*

***O.O. Likhanova***

*Head of the Department of International Relations of ISMAN*