# *Preface*

Micromixing is mixing at small scales in a turbulent flow. It plays an essential role in turbulent combustion and in flows with reactions of other types. Turbulent combustion is the topic of growing interest both because of its practical importance and because of the fundamental scientific questions it raises.

The practical systems with turbulent combustion embrace furnaces, burners, gas turbines, internal combustion engines, etc. The concern of the society in efficient, clean, and safe operation of these systems is an important driving force for the development of experimental techniques, analytical models, and computational approaches aimed at better understanding of turbulent combustion. In particular, such understanding is needed for designing combustion systems with minimal environmentally harmful emissions. For example, the strong dependence of nitric oxide (NOx) formation on temperature has made it necessary to gain a better understanding of temperature fluctuations and their influence on mean chemical reaction rates. Besides, the global environmental effect of combustion products (carbon dioxide) stimulates the research efforts towards more efficient and integrated combustion processes using fuels with a low C/H ratio.

Description and control of turbulent reacting flows is also challenging from the academic point of view. The combination of nonlinear fluid dynamics with nonlinear chemical kinetics incites very complex phenomena. A laminar flame, the standard object of the combustion theory, is not simple at all as it involves complex molecular transport, radiation, convection, and chemical kinetics with a wide range of time and length scales. Nevertheless, recent accomplishments in the combustion theory made the laminar flame an example of scientific triumph. Turbulence adds the complexity to the problem introducing a spectrum of hydrodynamic time and length scales and various uncertainties for the mathematical treatment. In general, turbulent combustion could be studied based on the fundamental principles; however, current computer capabilities are far from being sufficient for such studies. As a consequence, simplified approaches for simulating turbulent flames are put forward. These approaches imply that chemical reaction is a local process strongly coupled to small-scale turbulent and molecular mixing. The models used for simulating this process are based on the formalism of mathematical statistics. Flamelet models rely on the presence of clearly defined and relatively thin flame fronts, with a substructure obtained from laminar-flame calculations, and statistical description of, e.g., a single mixing parameter or a flame-position parameter. Alternatively, Probability Density Function (PDF) models do not assume a thin flame front and are designed to calculate the mean flame front structure directly. The essential advantage of the statistical methods compared to traditional moment methods is that chemical kinetics can be included in the exact form. However, their disadvantage is the necessity to model micromixing. Standard micromixing models incorporate turbulent mixing time scales neglecting molecular transport, although the latter is important in the presence of thin flame fronts. Development of better micromixing models is therefore a key issue, which has been addressed by many researchers worldwide.

Three years ago, a unique collaboration between five research groups actively involved in the development of new micromixing models was launched in the frame of the INTAS project 2000-353 entitled "The development and comparative analysis of different approaches to micromixing processes in turbulent reacting flows." At project completion, the International Conference on Micromixing was organized in Moscow. The objective of the Conference was to disseminate to the scientific community the results of the project, the state-of-the-art, and advancements made in experimental and computational studies of micromixing phenomena.

This volume is the outcome of hard work of several persons, and we appreciate their contributions. In particular, we acknowledge Ms. Olga Frolova and the staff of Torus Press Ltd. for their prompt and excellent service in producing the volume. Special thanks are due to Academician V. Fortov and Academician V. Klimov for their valuable contribution to the organizing the Conference. We acknowledge INTAS for the financial support of the project and do hope that this volume will serve as a useful addition to the literature on micromixing in turbulent reacting flows.

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