

Preface to Second Printing

This book has first been published in 2002 in a small amount of copies. Therefore, it soon became a rarity and is now available only from the libraries of largest universities, institutes and companies. Also, a limited number of most curious researchers and students have the book at their bookshelves. I hope that the layer of dust on its cover is not too thick.

To broaden the audience, publication of a revised and amended version of the book has been undertaken. I am grateful to Mr. Thomas Wohlbier, Vice-President of Trans Tech Publications, who kindly agreed to support my intention, in spite of not very favorable economic circumstances.

V.I. Dybkov, January 2009

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The main ideas, theoretical concepts, mathematical equations and experimental data laid in the basis of this book have been first presented in a series of papers published in the periodicals *Zhurnal Fizicheskoy Khimii*, *Poroshkovaya Metallurgiya*, *Journal of the Less-Common Metals*, *Journal of Materials Science*, *Journal of Physics and Chemistry of Solids*, *Journal of Materials Science Letters*, *Materials Science Forum*, *Defect and Diffusion Forum*, and *Journal of Alloys and Compounds*. A more generalized consideration of the process of reaction diffusion resulting in the formation of chemical compound layers has been given in my monographs 'Kinetics of Solid State Chemical Reactions: Growth of Chemical Compound Layers in Binary Heterogeneous Systems' (Naukova Dumka, Kiev, 1992, in Russian) and 'Growth Kinetics of Chemical Compound Layers' (Cambridge International Science Publishing, Cambridge, 1998).

Since the time of publication of my first papers, I have felt an incessant interest (both positive and negative but equally stimulating and therefore valuable to me) of the researchers, who are involved into the investigation of reaction diffusion and compound-layer formation at phase interfaces, to theoretical results presented in those works. Therefore, I decided to write a new book summarizing almost all I presumptuously think I know about the fundamentals of this subject.

It should be emphasized that this monograph only deals with the physico-chemical theory of formation of chemical compound layers. The consideration is based mainly upon my own views and results. This does not mean that I am not aware of the theoretical works of other investigators or intentionally ignore them. Simply, my views regarding the theory of reaction diffusion differ, in some cases diametrically, from the views of many researchers in the field. To avoid a compilation, I preferred to give only my interpretation of both theoretical and

experimental data on the reaction diffusion and solid-state chemical kinetics, supposing that those investigators, who are unable to agree with this interpretation, will have a strong stimulus to write their own books showing the erroneous character of one or another of my conclusions, and thus will be entirely satisfied.

The book is addressed, in the first place, to the actively working researchers, graduate students and post-graduates. As this part of scientific community has not got sufficient time to read lengthy books, I tried to be concise. Nevertheless, I explained, as far as I could, the main results in word, not relying only upon the clarity of mathematical formulae, their number in the book being probably somewhat greater than in other books written mainly for chemists, physicists and metallurgists. As all the formulae are obtained from very simple assumptions, the reader will doubtless be able to derive, analyze and apply them without any difficulties, in spite of their seemingly complex look.

The experimental data have been invoked in the minimal necessary amount in order to illustrate theoretical conclusions and consequences. This appears to be sufficiently justified since usually any actively working researcher is aware of the state of affairs with experiment in the field very well. Again, for students and post-graduates, an excess amount of experimental data, often contradictory, seems to be undesirable, producing an impression of the lack of any order in science. Those readers, who wish to know more details, are referred to original works quoted in the list of references, relatively long but of course not exhaustive.

The consideration is only devoted to the case where the layers of initial substances and the layers of growing compounds are parallel-plane. Probably, this does not mean that the results obtained are of no interest to researchers working, for example, in the field of sintering or reaction kinetics in powder mixtures. The processes analyzed in the book take place also during the interaction of powders but under more complicated (and in many cases poorly defined) conditions because the influence of the surface curvature and the extent of proximity of reacting particles prove important or may even be decisive in determining the kinetics of layer formation. For the works in this field, it is traditional to try to obtain a formal kinetic description of the reaction rate, the main aim being establishing the time dependence of the extent of transformation of the reactants into the final product(s). This question is not considered in the book at all. It has been analyzed in detail in many other books and it is very difficult to add something new and fresh to the well-known data.

It is not accidental that the consideration bears a polemic character. It was not my intention merely to give a number of ready mathematical formulae for the experimentalists to treat their data and to obtain some constants, although such a work is clearly also necessary and useful, and must therefore be welcome. However, it seemed to be far more important to show that, firstly, not all has yet been done in the field of theory of solid-state reaction kinetics and, secondly, some of wide-spread views should be modified or even rejected as contradicting not only the available experimental data but the common sense as well.

The results of this work may in turn seem to be questionable. I would be grateful to those readers, who could draw my attention to the facts necessitating the reconsideration of one or the other of theoretical consequences and conclusions following from the proposed approach.

I express my deep gratitude to colleagues from the Department of Physical Chemistry of Inorganic Materials, who were the first listeners of my works. This department has been organized and headed for more than thirty years by Professor V.N. Yeremenko, now unfortunately late. His contribution to my growth as a researcher in the field of layer growth is very significant. I acknowledge this contribution with sincere gratitude.

My thanks are also due to Professor V.V. Skorokhod for the help with publication of the book "Kinetics of Solid State Chemical Reactions" and many papers. I greatly appreciate the friendly support of my work by Professors F.J.J. van Loo, F.M. d'Heurle, J. Philibert and P. Gas. Numerous stimulating discussions with them in Paris, Aussois and Orsay in 1993, in Marseille during my stay as a Visiting Professor at Faculte des Sciences St. Jérôme in 1996, in Kyiv and Cherkasy during their visit to Ukraine in 1998, and in Paris during DIMAT'2000 meeting organized by Drs Y. Limoge and J.L. Bocquet were of special value to me. Of course, this does not mean that they necessarily share my views. Helpful discussions with Professors L.N. Larikov, B. Pieraggi, V.O. Lavrenko, G. Blaise, V.P. Kazimirov, V.M. Danilenko, O.I. Raichenko, A.M. Gusak, L.N. Paritskaya, V.R. Sidorko, W. Lengauer, K. Barmak, W.C. Johnson, H. Mehrer and Ch. Herzig are also acknowledged.

I would like to express my sincere gratitude to the researchers, who kindly presented me the reprints of their works. Each of these works has been used, to a greater or lesser extent, during preparation of this and previous books. I hope that the authors will be tolerant in those cases where my and their own interpretations of the results obtained are somewhat different. The future work, the most promising directions of which are tentatively outlined in the book, will show whose interpretation is more substantiated.

I am indebted to the publishers for their permission to reproduce some figures and especially to the authors (Dr. A.A. Kodentsov, Prof. W. Lengauer, Prof. H. Mehrer and others) for original drawings and micrographs. Doubtless, these made the text more vivid and understandable.

V.I. Dybkov