tions in the field of micro- and nanolithography, in the methods of dry highly productive etching, and on methods of testing structures with a complex topology at the intermediate and final stages of a technological process. The large volume of different kinds of information concerning the VLSI technology has been brought together in the book under review which is the twelfth volume of the well-known series on electrophysics. This publication is the English translation of the book by Yasuo Tarui which was published in Japanese in 1981 and in a Russian translation under the title "Fundamentals of VLSI technology" (edited by V. G. Rzhanov) in 1985 by the publishing house "Radio i svyaz".

The author is a well-known Japanese scientist, a member of the Joint Institute of VLSI Technology. He has concentrated the principal attention on problems of forming a topological design with submicron dimensions of the elements.

The material being presented is subdivided in the book in the following manner.

The first chapter gives as an introduction a brief historical outline of the approach to the idea of creating VLSI, and also classifies the principal modern methods of forming a microdesign on a crystal as one of the most important aspects of the VLSI technology.

The importance of this is particularly emphasized by the content of the second chapter in which electron-beam lithography is described. Without claiming to be exhaustive this chapter nevertheless encompasses all the aspects of tracing a microdesign by electron-beams. The principles of construction of different electron-beam apparatus are described, as well as the present status in the development of specialized sources of electrons and of electron-optical systems. The principal factors are examined in detail which determine the accuracy and speed of the lithographic process, and also the methods of correcting aberrations and decreasing the influence of the "proximity effect" by means of suitable software. Much attention is devoted, and this is very valuable, to software; in particular, structural schemes of the lithographic process are given for the principal methods of exposure. At the end of the chapter a description is given of the electron-beam apparatus manufactured in Japan.

The third chapter is devoted to methods of transferring microdesigns onto silicon plates. Practically all the modern methods using far ultraviolet and x-ray radiations as well as electron beams are touched upon. In contrast to the second chapter the author here restricts himself primarily to describing the principles of construction and technological parameters of existing apparatus. At the end of the chapter information is given on commercially available resists for microlithography.

The fourth chapter is devoted to methods for checking masks prepared by using electron-beam apparatus. A detailed classification is given of methods and their possibilities for checking geometrical dimensions of masks and the defects present in them. Construction of modern optical and electron-optical apparatus for automated checking of masks under conditions of mass production is described.

The fifth chapter is devoted to obtaining crystals for VLSI. The principal attention is devoted to defects in crystals, to causes leading to their appearance, to modern methods of discovering and identifying them.

The sixth chapter brings together information on the technology of forming microelements on a crystal. However only some of the technological processes, such as dry etching for obtaining microdesigns, laser annealing of implanted layers, methods of obtaining insulating and conducting films are touched upon.

The seventh chapter examines problems of checking and testing integrated circuits, in particular checking and testing at the stage of design of VLSI, the principles of analysis and checking of parameters of large integrated circuits and testing VLSI as a complex system.

The concluding eighth chapter is devoted to problems of designing and constructing VLSI. The content of this chapter is interesting because here a discussion is given of the fundamental limits to the increase of the degree of integration and definite predictions are made of possible improvements in the parameters of apparatus. Here also are given examples of a number of basic structures of modern integrated circuits.

In spite of the fact that the author does not touch upon a number of new directions in technology, for example, such as ion-beam lithography, the latest achievements in MOS hydride and molecular-beam epitaxy, the book is useful because it gives a unified overview of the VLSI technology. It is of definite interest for scientists and engineers engaged in the development and technology of making integrated circuits. The book is useful for graduate students and senior undergraduate students as a textbook.

Numerical and physical aspects of research on aerodynamic flows

S. G. Chefranov

Usp. Fiz. Nauk **156**, 553–555 (November 1988)

Proceedings of a Symposium on Numerical and Physical Aspects of Aerodynamic Flows III. (Ed.) T. Cebeci, Springer-Verlag, New York; Berlin; Heidelberg; Tokyo, 1986, Pp. 484.

The third symposium on numerical and physical aspects of research on aerodynamic flows took place at California State University (Long Beach) between January 21 and 24, 1985. Fifty papers and twenty brief communications were presented.

For this collection twenty-four papers were selected

which reflect the present status in the development of numerical methods of investigating two-dimensional and three-dimensional aerodynamic flows utilized, for example, in connection with design of constructions of naval, aeroplane and rocket technology. In contrast to the preceding volume II, devoted primarily to an analysis of two-dimensional flows, the present volume provides a broad presentation of research on three-dimensional problems of subsonic and supersonic flows around aerodynamic profiles of different type. Particular attention is devoted to phenomena of separation of flow in which strong interaction of the flow in the boundary layer occurs with regions of flow which are quite far removed from the profile around which the flow takes place.

The collection of papers consists of four parts and begins with a review article by T. Cebeci and J. H. Whitelaw which was specially prepared for this volume.

The first part of the collection consists of three papers devoted to the problem of hydrodynamic stability and an analysis of transitional turbulent phenomena. It begins with the article by J. T. Stuart dedicated to the memory of Professor K. Stewartson. In this paper in addition to an analysis of different historical stages of the development of the theory of hydrodynamic stability linear and nonlinear aspects of the stability of plane Poiseuille flow are examined, and also the problem of turbulent instability of the boundary layer. The article by R. Michel, E. Coustols, and D. Arual investigates the special features of transitional phenomena in three-dimensional flows around obstacles and, in particular, the necessity of taking into account effects associated with transverse flows is noted. The paper by R. Narasimha and J. Dey which concludes the first part of the collection is devoted to an analysis of the rate of formation of turbulent spots in two-dimensional boundary layers.

The second part of the collection in conformity with the table of contents consists of nine papers relating to investigations of two-dimensional flows around aerodynamic profiles near the separation zone. It begins with the article by R. E. Melnik and J. W. Brook which develops the "method of rapid interaction" between the flow in a thin turbulent boundary layer and outside it for subsonic and supersonic flows with extensive regions of separation at high Reynolds numbers. On the other hand, the paper by H. K. Cheng and C. J. Lee examines topics associated with the problem of separation of a laminar flow around a two-dimensional profile at relatively low Reynolds numbers $\mathrm{Re} = 10^4$–10^5, which arises, for example, in studying the mechanism of movement of live creatures in aqueous and aerial media, and also in analyzing the operation of windmills and miniature aircraft.

A considerable number of the papers in the collection as a whole, and in its second part in particular, are devoted to the development and improvement of the methods of joint solutions of equations of a boundary layer and equations of an ideal liquid for flow far away from the profile around which flow takes place (the so-called method VII: Viscid-Inviscid Interaction) for describing the observed phenomena of separation of flow. It is specifically due to the success achieved in developing method VII that quite a few new results have been obtained in solving three-dimensional and non-steady-state (two-dimensional) problems of aerodynamics. Part 3 of the collection consisting of five papers is devoted to investigations of non-steady-state flows around obstacles, associated with problems of constructing more efficient helicopter rotors, gas turbines and different kinds of mobile (regulating and checking) aerodynamic surfaces in constructions of modern flight technology. Thus, method VII is developed for non-steady-state flows in the paper by J. C. Le Balleur and P. Girodroux-Lavigne and also in the majority of the papers of the third part. An alternative method based on the application of unsteady Navier-Stokes equations was used in only a single paper by H. N. Ghia, G. A. Osswald, and U. Ghia.

In the fourth part of the collection devoted to an analysis of three-dimensional flows and consisting of six articles such methodology based on the direct use of the Navier-Stokes equations was also used only in a single paper by J. Cousteix, X. de Saint-Victor, and R. Houdeville.

Thus, recently definite preference is exhibited towards using the improved method VII which allows one to analyze sufficiently accurately the phenomena of flow separation, since the alternative method based on application in numerical calculations of averaged Navier-Stokes equations requires considerable effort in overcoming all kinds of numerical instabilities restricting the ability to predict turbulent flows at large Reynolds numbers.

On the whole the collection is well put together and illustrated (265 illustrations). There are 640 references, and the content of the articles collected in it can be of interest for specialists in the field of aerodynamics.

Because of a polygraphic defect in the volume under review on pages 183–214 instead of two articles by F. G. Blottner and by U. Mehta, K. C. Chang, and T. Cebeci a text occurs which has no direct relation to the topic of the collection (for example, on p. 200 there is a picture of the transverse section of a human head, etc.).

Translated by G. M. Volkoff