Analysis and Generalization of Scientific and Educational Information Book in the Field of Nano-Electronics

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In this paper analysis and generalization of the scientific and educational properties of information textbooks on nano-electronics, created from the scientists of the Institute of Electronics at Bulgarian Academy of Sciences, the Power Institute at the Academy of Sciences of Moldova, the National Technical Universities of Ukraine: "Kiev Polytechnic Institute" and "Polytechnic University of Lvov" is presented. The prepared monographs are also textbooks and they are based on the authors own most significant research results and on results obtained in leading companies and academia of various developed countries in the world.

Анализ и обобщение на научните и методически информационни учебни пособия по наноелектроника (В. М. Спивак, Е. Г. Колева, А. Г. Власюк). В тази работа е представен анализ и са обобщени научните и учебните качества на информационните учебни пособия по наноелектроника, създадени от учени от Института по електроника на Българската академия на науките, Институт по Енергетика на Академията на науките на Молдова, Националните Технически Университети на Украина "Киевски Политехнически институт" и "Лвовска политехника". Издадените монографии съсъ учебници и те са основани на авторските собствени най-значими изследователски резултати, както и на резултатите от научните изследвания на някои водещи фирми и академичните организации на различни развити страни по света.

Introduction

Nanoelectronics is an undisputable new strategic direction of the scientific and industrial development of the world. The nanoelectronics is based on the last technologies and research results of the developed countries. The progress of microelectronic technologies was one approach to develop nanotechnologies, but now the development of nanotechnologies is in close connection with the achievements of nanoelectronics. In the next decades nanotechnology development and applications will determine the position of every developed country in the world. This is the origin of sharp concurrent competition of corporations, the economic activities of which are in the field of national security and weapons. In the same time the existing experience in research and development indicates the need of: working out a strategy for the development nanotechnology devices and nano-materials; building a platform for joining and the coordinative use of the existing scientific, technology and educational resources; for the close cooperation of governments with business.

In this paper some information and analysis of monograph and text book [1-6] elaborated by the researchers and lecturers of few leading academic organizations in Bulgaria, Ukraine and Moldova are given.

Contents and matter of books

The aim of published books was to introduce to the possible readers - scientists, lecturers in Universities, experts in industry and students in technical specializations - the problems and the achievements of nanoelectronics and fabrications of nano-materials, nano-devices and nano-systems. The nanofabrication methods of nano-devices, nano-materials and systems, the methods of investigations and visualization of nano-objects, the physical processes in nano-devices are also presented.

In the beginning Prof. G. Mladenov wrote two books [1, 2] as an attempt to help students of Technical University - Sofia from specialty Microelectronics to understand better the important role of electron and ion beams in the going down competition in the submicron region of critical dimensions of the electronics circuits, as well as to
show the open room for nano-electronics as the near future of technology development. Then the scientists at the Institute of Electronics at Bulgarian Academy of Sciences and researchers and lecturers of Faculty of Electronics at National Technical University of Ukraine "Kiev Polytechnic Institute", together with scientists from Power Institute at Academy of Sciences of Moldova joined knowledge and experience in the published books [3-5] based on own more considerable research results and executed some generalization of the results of leading companies and research organizations from the developed industrial countries. An important achievement of these monographs [1-5] is the short, but substantial analysis of the methods of fabrication nano-dimensional thin films and structures. There is base information on deposition of thin films by thermal evaporation of materials in vacuum, by molecular-beam epitaxy, and by atomic layer deposition. In these monographs the physical processes at ion sputtering, at operation of triode-plasma-sputtering deposition system, at ion, high-frequency and magnetron sputtering deposition systems are recognized. Reviews are made on the processes at ion-beam, reactive ion and ion-plasma etching; the physical processes at penetration of accelerated ions and electrons in solid samples; peculiarities of ion implantation, conductivity of surface layers in implanted silicon, as well as ion-implantation equipment is described. In [1,3,5] the physical base of electron and ion lithography, data for application of these methods of submicron treatment of substrates, as well as the mechanical probe use for investigation of nano-dimensional reliefs and for nano-lithography are given. There experimental and computer-simulation results for modification electron resists by accelerated electrons and ions, some examples of regression analysis applications for improvement the results of electron exposure and development are also given. There the methods of use atomic-force and scanning tunneling microscopes for lithography goals are also described.

In the books [2, 3 and 5] the reasons for explosive development of nano-technologies and various approaches in fabrication of nano-dimensional nano-devices are presented. Description of the difficulties of development nano-dimensional critical element of semiconductor integral circuits and prospective of creation new building elements, based on new principles as tunneling effect, superconductive conductivity, electron magnetic spin transport, giant magneto-resistivity, application of quantum dots in cellular automata etc. is made. Methods of surface analysis of nano-materials and structures using electron and ion beams, as well other methods for visualization and control characteristics of the nano-dimensional objects and particles are given.

The book [4] is written aiming to be a textbook in the region of nano-materials and functional devices nanoelectronics. There the information is a continuation of the data on the technologies and the ideas, developed in books [1-3]. In this monograph the principle of self-structuring of nano-dimensional structures on example of silicon with pores and nanopores as well as silicon-based composites are described. Discussion on the connections of technology processes and properties of the obtained materials as some characteristics of the produced devices is made. Another important group of nanomaterials is the carbon-based nano-materials as fullerenes, nanotubes, diamond like films, graphen. In [4] there are presented shortly the methods of fabrications and the base characteristics of these materials, as well as some their applications. There the functional devices of more important areas of nanoelectronics as photonics, bio- crio- and molecular-electronics, magneto-electronics or spintronics, sensors and nano-electro-mechanical nano-components and systems are recognized.

At the end of presented series of books a group of lecturers from leading Technical Universities in Ukraine from Kiev and Lvov new text-book [6] was worked out, using the materials in [3-5] and own experience, devoted on quantum-mechanical base nanoelectronics. There are discussions on the base physical characteristics of semiconductor and carbon-based structures. The behavior and energy spectrum of quantum-mechanical particles in potential gap with various shape and dimensions, the peculiarities of tunneling of particles through potential barrier and resonance-tunneling structures are discussed. There are data on the density change of the free electrons at variations of the system dimensions and at strong outer magnetic fields. The base information on 2D-crystalles, semiconductor super-lattices and carbon-based nano-structures are presented. The specific physical properties and peculiarities of energy structure of these lattices and films are also discussed. After every chapter of [6] conclusions, questions and examples for calculations are given.

**Discussion**

In the books [1-6] original authors results are presented and the trends of the leading scientific school and industrial research in the world in field of nanoelectronics are analyzed. The created ideas help understanding the base technologies for fabrications
and the processes in nano-devices and nano-materials, as well as the processes of characterization and visualization of nano-dimensional materials and devices. Reading these books will permit engineers and aspirants of various specialties of Technical Universities in Ukraine, Bulgaria, Moldova and Rumania, probably in Russia too, to create new concurrent nano-materials and nano-devices.

In the books the difference of the behavior of nano-dimensional materials from the conventional materials due to dimensional effects, as from classic nature to quantum-mechanical nature are demonstrated. For example: solvent penetration, melting temperature, electro-conductivity and heat-conductivity as well as the electron tunneling, quantum energy-levels and density of particles in the gaps, electron spin’s role etc. are discussed. As a result, non-transparent materials could become transparent ones, the inert materials can display catalyst properties, some metal powders could be ignited, insulating materials could become electro-conductive and so on.

In [1] the presented original results are for example: electron beam space-charge compensation by generated ions; computer simulation of technology electron guns based on phase analysis, electron and ion lithography as well some data for ion implantation. In [2] the problems of microelectronics in its way to nano-dimensions, due to mentioned quantum effects are deeply discussed. Some new applications as spintronics, giant magneto-resistivity effect, tunneling, the two-pole devices applications including these of newly invented memristors are described. In [3] nano-electronics based on new building elements is presented. Specific interest presents the chapter on methods for investigation and analysis of nanostructure; the various technologies for realization of nano-structures and the chapter for lithography with mechanical sharp-probe (principle of AFM and STM). In [4] two main directions of investigations and development of nano-technology are marked: a) obtaining new materials with uncial properties due to morphology of structure, containing elements of 1 to 100 nm; and b) investigation the possibilities to utilize the conventional materials in nano-dimensional region. The important role of interfaces between micron’s part and nano-dimensional part of systems was appointed. This takes place also for nano-materials (nano-luminescent layers of the displays; nano-separators in electro-charging sources; electro-optic nano-coverage for windows; solar sources with nano-dimensional elements; nano-sensors and nano-electro-mechanical devices; nano-

additives to cosmetic and medical materials.

Books [5, 6] are an extension of [3, 4] for readers from Moldova (respectively Romania), as well from Ukraine. The progress due to use nano-component in information systems - as example magnetic heads and memories is appointed. There is success in the decrease of the used energy, increase in the functions, use of self-renovated materials and components for the development of the future less-defected adapting systems and not on least place - the future progress in quantum informatics and quantum computers.

Important aspect of the development of nanomaterials, devices and systems is the optimization of the methods for investigation, modeling, visualization and quality improvement. The measurements of the distances must be of atomic dimension exactness, and time resolution in the near future will reach terra- or ato-seconds.

**Conclusions**

The first attempt writing text-books in the field of nano-electronics is met well in Ukraine, where the books [3, 4, 5] were awarded with honor diplomas and certificates from Ministry of educations and from Academy of pedagogics sciences. In Bulgaria few Technical Universities (in Sofia, Plovdiv, Varna) recommend the books [1,4] as textbooks for some educational courses for bachelor or master degrees in various specialties. The book [5] is a textbook for Technical University of Chisinau and for University “Polytechnics Bucharest”. Authors hope is that the books will be useful for improving the knowledge on nano-electronics of teachers, students and experts, transferring the last results and approaches, as well the scientific and technical benefits of nano-electronics development.

**REFERENCES**

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Nanoelectronics is an area which encompasses, among others, subtopics such as spintronics, topological insulators and carbon-based electronics (principally carbon nanotubes and graphene). From: Introduction to the Physics of Nanoelectronics, 2012. Related terms

An interesting example of the latter can be found in a work of Lieber and co-workers in the discussion to follow. Key necessary elements for circuit realization are available via the core–shell configuration of NWs (Dong et al., 2008). To begin, as described in Section 12.5.1, the selection of core–shell materials determines the electrical characteristics of the given NWs. 81.8.2 Generalizations. 81.9 Fock matrix. 82 Density Functional Theory. Nanotechnology is very diverse, encompassing numerous fields in the natural sciences. There has been much debate on the future implications of nanotechnology. Nanotechnology has the potential to create many new materials and devices with a vast range of applications, such as in medicine, electronics and energy production. As when integrated electronics were developed, nanotechnology is currently in the phase where component production methods, characterization methods, tools for manipulation and integration are evolving by mutual support and convergence. Difficult nanointegration. International Scientific â€“ Practical Conference «INNOVATIVE INFORMATION TECHNOLOGIES». Section 2 INNOVATION INFORMATION TECHNOLOGIES IN SCIENCE. Anop M., Mikhalichuk V. APPLICATION OF PARTICLE SWARM OPTIMIZATION ALGORITHM FOR PARAMETRIC RELIABILITY OPTIMIZATION PROBLEM. Mekhanov V.B., Domnin A.L. MODELING IN CPNTOOLS BITRATE MEASUREMENT ALGORITHMS IN THE PACKET-SWITCHED NETWORKS. 26. Ivanov V.K, Palyukh B.V., Sotnikov A.N. INTELLIGENT SUBJECT SEARCH SUPPORT IN SCIENCE AND EDUCATION. 34. Molecular electronics is presented as the field of science that investigates the electronic transport properties of systems in which individual molecules are used as a basic building block. The dimensions of some molecular systems are a few nanometers, and therefore The remarkable predictions of Gordon Moore in 1965, that the number of transistors per square centimetre on a silicon chip doubles every 18 months [4], has encouraged the constant quest for new technologies that could complement the silicon-based electronics, and molecular electronics is one such technology.