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Novel Approaches to Nanosensory Systems Development

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Abstract Last achievements in physics and technology of nanostructured materials make possible to elaborate the nanosensors and their smart systems of different application based on quantum effects taking place in nanomaterials with semiconductor properties. The solution of this task is closely connecting with novel nanotechnology methods and tools for preparation of semiconductor nanosystems. Elaboration of quantum effects based devises very depends to micro and nanostructures properties. The hot atom clusters formed in the laser-plasma organized vapor are depositing on the substrate and performing in relevant structures of different sizes. At sub molecular level the physical effects are very sensitive to size of the film and its structural characteristics. Using this kind of nanostructured films it is possible to organize spintransport based processes and build up the quantum systems responsible for high effective sensory devices.

Keywords Nanosensors, Devises, Nanostructured materials, Quantum effects, Structural characteristics, Semiconductor properties

1. Introduction

Concern over the consequences of harsh environmental pollution, particularly in nuclear power engineering and military base sites rise to an increasing demand for suitable means of monitoring a number of radioactive sources enriched gases, vapors at and around the occupational exposure limits. For instance, radioactive pollutants generated directly or indirectly, as a result of nuclear waste influence on different substances working in nuclear power stations (water, gases, metals, etc.) or existing nearby radioactive materials places.

The need is for devices that can achieve the necessary sensitivity at a cost that will not prohibit their widespread deployment and with the capabilities to provide quantitative information as well as alarm functions.

These devices and particularly detectors of nuclear radiation with autonomous energy supply are very useful for illumination and prevention of nuclear materials illegal transportation and transfer.

The development of new range of sensors has provided instruments with enhanced selectivity and sensitivity for harsh, radioactive waste polluted environment monitoring [1].

Development of effective sensors and sensory systems (networks) united in artificial intelligence grid is also very important for Black Sea and Mediterranean basin areas, where are some rather problematic territories in point of view of different radiation waste: Martkophi and Matkhoji-Udzluuri sites in Georgia, Artik and Metsamor in Armenia, Kozloduj in Bulgaria and others.

During the Cold War era, there were two major competitive research groups making gamma and neutron radiation detectors (sensors): Lawrence Berkeley National Laboratory Semiconductor Detector Group and the USSR's Middle Machinery Ministry (comprising Kurchatov Institute of Atomic Energy, Giredmet Institute of Rare Metals, Institute of Radioisotope Devices, etc). Both competitors were focused on the development of semiconductor-based radiation detectors and their applications. The best sensor material for gamma radiation sensors was, and still is, ultra pure Ge and Si or Ge doped by Ga impurities with acceptor concentration up to 1016 cm^{-3}. For neutron radiation measurement the B isotopes contained Si was developed [2].

Determination of appropriateness and mechanisms of the influence of the isotope effects on the properties of the medium opened new possibilities to pass from the technology of isotope substances pure in the sense of admixtures to the technology of pure isotope substances. Purposeful usage of isotope effects in certain physical phenomena and processes will substantially extend the sphere of utilization and production of stable and unstable isotopes [3].

Such approach to isotope problem leads us to perspective branches of physics and technology – physics and isotope stimulated phenomena and isotope material science. This relatively new field of solid state physics as well as of molecular physics includes the study of isotope effects of various media.

Isotope effect is very effective for nuclear radiation sensors preparation. Today, nuclear radiation detection systems exist utilising a variety of solid state detectors. The solid state detectors are based on semiconductor material

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such as silicon, germanium, cadmium telluride, zinc oxide, etc. A major advantage of such detection systems is their extremely high energy resolution.

Another prospective application of isotope effects is their utilisation in quantum spin based devices. In the last years the strong attention was paid to development of so called “high temperature boron and its compounds because of their suitable physical and chemical features as the sensitive elements for temperature and nuclear radiation sensors. They are semiconductor materials (mainly boron and boron carbide) with a high melting point, mechanical/ chemical strength in corrosive media and strong atomic bonds providing high stability in the radiation area. To raise its radiation resistance under neutron irradiation, boron should be enriched with ^{11}B isotope.

In case of semiconductor Boron based elements preparation enriched by ^{10}B following n, α nuclear reaction it is possible to build a very sensitive neutron detectors [4].

Last achievements in nanoscience and nanotechnology lifted the effectiveness of semiconductor sensory devices on the higher level. It had been arisen possibilities of creation of nano and micro size radiation sensors and sensory systems as well as their networks. Novel achievements well indicate that micro – and nano – worlds are continuously merging. In some cases “nano” products emanate as natural, inevitable extensions of their well established “micro” precursors simply by the downscaling of conventional technology. Following that in the nearest future the similar extension should be elaborated for the “pico” matter, and as result – to picotechnology [5].

In general there are two fundamental approaches for the new nano materials and devices realization: In a top down approach structures are miniaturized mainly by means of well established metal powders or semiconductor structures and instruments fabrication technologies; In a bottom up approach materials as well as functional systems are made by assembling of nanosized components like carbon nanotubes or DNA. There are several brilliant phenomena associated with micro – nano size materials and devices. At the same time it is necessary to take into account and find the limit of the miniaturization of micro – and nano – structures. It is very important to identify the classes of condensed matter substances and systems that are better suited to micro – nano world, where they will operate most effectively.

Nowadays, due to issues of nuclear non-proliferation and international security, new and much stricter requirements for nuclear radiation sensors and sensory systems have been created. The issue of developing novel sensors compliant with the new requirements poses interesting technical challenges for researchers and engineers. The new sensors need to rely on one or more sensing mechanisms and produce a signal that indicates the nuclear/ionizing radiation value. It is also necessary to operate by so called smart or intelligent sensor systems, in order to have precise measurement information about nuclear/ionizing radiation.

Nano micro sensor systems integrate and interface multiple core technologies and related devices to implement a variety of functions. They can be implemented through scalable homogeneous, or heterogeneous hardware integration technologies, in order to advance the miniaturisation, functionality and reliability of the sensor, processor, actuator and communication functions. Power autonomy (consumption and supply) is a common issue. In the medium term, there is growing industrial interest to integrate nanosensors in smart (intelligent) microsystems, mainly due to an increase in sensitivity, device simplification and associated cost reduction. The development bubble chart represents the range of sensors and sensory systems capabilities and activities and covers the span from underlying science to the engineering developments required to deliver devices, instruments, and systems. At the same time, the existence of integrated technologies facilitates the transfer of information for improvement of appropriate sensing mechanisms and devices (Fig.1), [6].

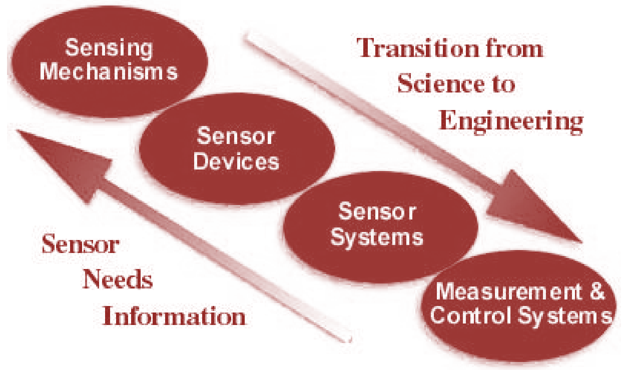


Figure 1. Sensor Technolog Overview

2. Boron Isotopes Based Semiconductor Nanosensors

Last decades our research group started the work to develop novel boron-based nanosensory elements for temperature and neutron sensors that can operate in harsh environments (corrosive media, nuclear radiation, etc.) Boron is a wide-range high temperature semiconductor with a prohibited energy zone of about 1,6 eV. Boron carbide (B_4C) and some other boron rich compounds have a similar forbidden energy gap, which defines their electrical resistance. High mechanical and chemical strength in various corrosive media, and the possibility to change the isotope content from ^{11}B to ^{10}B in almost every concentration range, allows to improve the radiation resistance of boron based sensors and nanosystems. Boron (and its compounds) crystalline and compact pellets are possible to be prepared by different metallurgical methods: vacuum synthesis, melting zone, free crystallization, vacuum hot pressing, sintering hot compaction, self-propagation high-temperature synthesis, gasostatic pressing, etc. Study of their properties such as the temperature resistance, voltage-current characteristics, ice melting point sensitive response, structural stability, etc. showed a high temperature resistance coefficient and linearity of voltage-current parameters within their operational range. Using such approaches researchers have managed to produce compact pellets made of boron, boron carbide and aluminium dodecaboride etc. Typically, the pellets had a cylindrical or thick disk shape, high density, low concentration of metallic impurities, and room temperature electrical resistance in the range 10^6 - 10^8 Ohm.m. One more advantage of boron and its compounds is the preparation of sensitive elements in types of ceramic thin films, nanostructured elements, quantum dots and other nanosystems, which make possible to obtain different properties materials and sensitive elements [7-9].

Temperature dependence of boron, boron carbide and aluminum dodecaboride electric resistance was studied in 150-750 K temperature range. A thermostat provided the temperature constancy by the following transient phases: melting, boiling and eutectics solidification. The points corresponding to the eutectic solidification temperatures were obtained using aqueous solutions of the eutectic composition, which form cryohydrates coinciding with the liquid phase by their composition. A Chromel-Alumel thermocouple and a platinum resistance-thermometer measured the temperature at the constant point. The electric parameters of the sensitive elements were measured with a measuring bridge circuit. The example of temperature dependence of the resistance of the aluminum dodecaboride enriched by ^{11}B is shown at the fig.2.

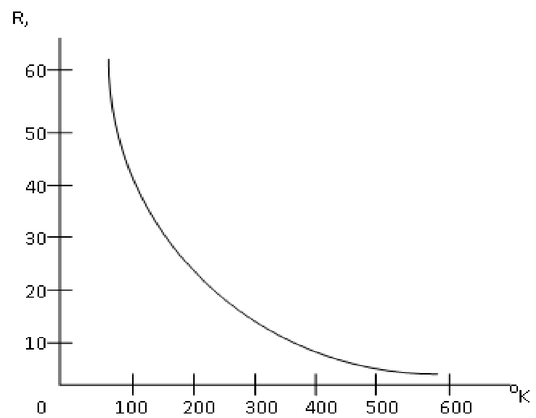


Figure 2. Temperature dependence of the electroresistance of AlB_{12} enriched by isotope ^{11}B

From this thermoresist characteristic is seen that good operating interval for AlB12 based temperature sensors is between 150K-500K. The volt-ampere characteristic of the sample gives the opportunity of increasing the circuit sensitivity up to 10mV/grad over the whole temperature range. This sensor is characterized by high accuracy of the measurement, the error not exceeding 0.002. The sensor can be designed as a miniature instrument for instantaneous responding to small temperature variation. It can be useful as a part of micromachines and all types of microsystems, which need the precise temperature measurements and works in hazardous conditions. It also can be applied to various areas of engineering, medicine, atomic power installations, space power systems etc. In latter case, if a ^{10}B isotope is replaced by the ^{11}B one; then such a microsystem can work in a radiation field without disturbing the structure with a sufficiently large fluence of neutrons. It is well known that thin films technology has a lot of specific advantages for sensor preparation. At the same time it is a very powerful fabrication process for microsystems mainly because of very small volume involved in thin film sensors and extended surface, which helps to exhibit a strong reaction to their environment it may be, temperature, radiation or the partial pressure of a specific gas.

One more prospective application for boron based semi-conductor films is B4C temperature sensors. At the fig.3 is shown the one simple variant of nuclear radiation-hardened B4C temperature sensor enriched by 11B [10].

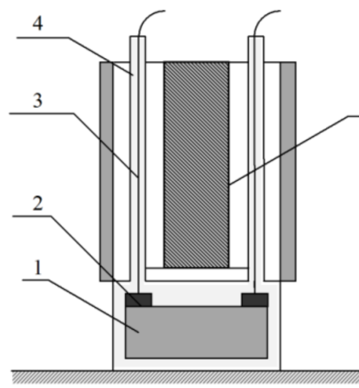


Figure 3. ^{11}B enriched B_4C sensory element based temperature microsensor: 1) Disk-shaped plate containing boron; 2) Nickel ohmic contacts; 3) Electrodes; 4) Chemically resistant lacquer (to protect sensor element, contacts and electrodes from moisture and corrosive medium effects); 5) Sensory element

For the production of boron, boron carbide and aluminum dodecaboride crystalline films mostly effective methods are physical vapor deposition (PVD) and chemical vapor deposition (CVD) processes. In these technologies the substrates usually are heated to temperature of 300K to 500K for PVD to improve both the sticking coefficient and the morphology of the layers and to 400 to 1200K for CVD processes also to allow the chemical reaction [11].

The historically first PVD process was the high vacuum evaporation deposition, which used thermal heating powered by electrical resistance heaters or electron beams. Nowadays the development of PVD process is going to the direction when sputtering methods mainly in magnetron configuration supports the evaporation. Due to the high condensation energy of the particles and the option of an additional ion bombardment on the substrate the morphology and sticking coefficients of these layers can considerably be improved compared to evaporated films and reactive gases such as oxygen, nitrogen, methane etc. added by inert ones. These help to prepare oxides, nitrides, carbides and its metal compounds with necessary stoichiometry and properties. In newly developed processes the CVD methods mostly applied to deposit dielectric layers like SiO2, Si3 N4 and sometimes SiC in combination with plasma and low pressure technologies.

Among the modern technologies for the thin film sensor preparation method of laser spraying is very suitable for refractory elements and compounds [12].

The boron, boron carbide and aluminum dodecaboride thin semiconductor films were produced by the laser deposition. In the experiments pulsed solid-state laser on an YAG: Nd+3 crystal was used, the frequency of pulse following being 50 Hz. Schematic diagram of the laser plasma deposition device is shown at the fig.4.

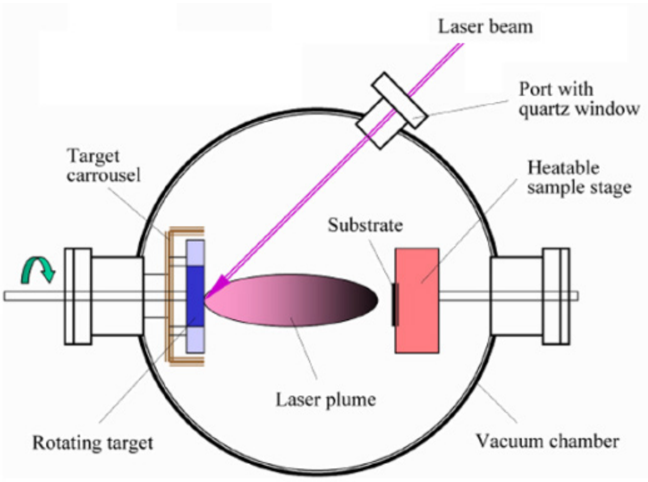
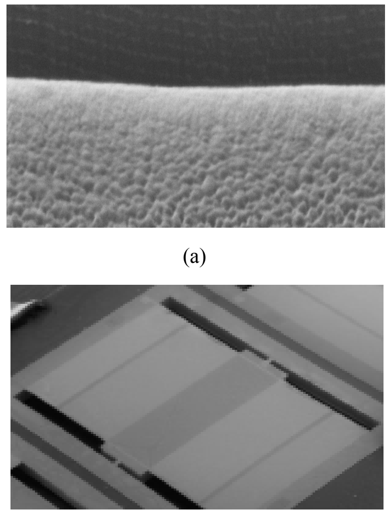


Figure 4. Laser Plasma Deposition Process

The boron, boron carbide and aluminum dodecaboride disk-shaped pellets usually are used as the targets, and silicon, silicon oxide waters as well as some other materials layers and sandwiches as the substrates. During the laser deposition a strong beam of laser radiation (power density 106 - 109 W/cm^2) is being directed towards the targets and provokes its evaporation. The substrate upon which the film is formed is oriented mainly perpendicularly towards the target. A simple physical model of laser evaporation shows that approximately 104K temperature and 0,5GPa pressure are developed upon the surface of the target. Therefore the laserplasma contains high energy ions, atoms and clusters with different types of bonds. During the deposition a synchronous bombardment of growing film with high-energy ions and electrons may be used. The produced films electric properties depended on both the crystalline structure and the films stoichiometric composition. Besides it is possible to reach in films the appropriate isotope concentration of 10B, 11B, 12C, 13C 14N and 15N. There are a number of thin film sensors which can be produced on the basis of boron and its compounds films and layers: temperature, micromachine, chemical, nuclear radiation etc.

Due to their compatibility with microelectronics, their small sizes and microstructuring, boron compounds based thin film temperature sensors are suited to be integrated into “microsystems” in combination with different types of microdevices for different uses (fig.5) [13-16].



(a)

(b)

Figure 5. Novel boron-based nanosensor: a – surface; b – element

3. Quantum Effects in Nanostructures and Nanosensors

Radiation sensors are systems that act as interfaces between incident radiation and imaging systems. The most effective way for organization of information transfer in these kind of systems is quantum effects utilization.

Recent study of the spin transfer in semiconductor nanosystems enriched by ferromagnetic dopants have determined the most essential mechanisms, responsible for spin transport properties, best solutions for electronic and magnetic structures preparation and for the development of technologies of spintronic materials with controlled disorders.

Elaboration of precise methods of semiconductor nanostructures and systems preparation is extremely necessary for combination of well controlled spin electronic properties for semiconductors with additional possibilities of devices with the spin degree of freedom of current carriers. For this kind of quantum nanosensors it is the central problem today the search of an effective way for the spin injection in a semiconductor sensory element from the spin-polarized reservoir [17, 18].

Generally quantum sensors are devices those exploit quantum correlations to achieve a sensitivity or resolution that is better than can achieved using only classical systems can measure the effect of the quantum state of another system on it.

The sensors operating with the tunnel magnetic junctions (MTJ) are the good example of spintronic quantum devices. There ferromagnetic electrodes are divided by very thin dielectric layer, and electrons are tunneling through a nonconducting barrier under influence of applied voltage [19].

Possibility of development of these sensory devices is connecting nowadays with the creation of spin transistors. In this case spintronic devices may not only switch or to detect electrical and optical signals, but also to enhance them, and to be used as multifunction units. Only in this case spintronic devices can not only switch or detect electrical and optical signals, but to enhance them and can be used as multifunction units. Nanospinelectronics, based on usage of magnetic materials, represents new area of science and engineering. The reason to that is the perspective of creation of principally new devices for information technologies operating as charge, and spin degree of freedom of carriers, free from limitations inherent for metal spinelectronic devices. The main structural property of materials in which we can observe novel nano dimension phenomena is their unperfection – high concentration of different defects connected with several impurities of metal and non metal chemical elements. So, novel very exiting properties of semiconductors are determined by impurities and their disordered distribution. At the same time the last theoretical and experimental achievements have shown that disorders in semiconductors should be controlled – should have a necessary rules and regulations [20].

By these approaches it is possible to define the link between matter and information which is most evidently manifested by the molecular constitution in building molecules connecting in given order. The initial formation directs the synthesis of sequences, which logically are not random; there is an optimization of structure within the system. Such optimization should be expressed in terms of fuzzy entropy and it relates directly to the definition of information. Following novel achievements we could integrate the science and technology of small scale structures (nano, pico structures [6]), quantum size elements based physical effects and information-communication processes, which brings us to novel applied science discipline – quantum information technology (QIT) [21].

All approaches treat the nonmagnetic and ferromagnetic metals as free electron materials. Based on the assumption that the elastic scattering time and the inter band scattering times are shorter than the spin flip times the two current model is adequate to describe and explain the observed magnetoresistance effect. However, it is unable to quantify the bulk and interface spin asymmetry parameters and spin relaxation lengths As since Magnetism originates from the spin of the electron, having a much larger magnetic moment than the nucleus of an atom. A net electron spin in an atom results from flexibility of ordering in the electronic arrangement of the electrons around the nucleus and the requirement for the electron wave function to obey the Pauli exclusion principle, that is: the complete wave function of a two or more electron system has to be antisymmetric with respect to the interchange of any two electrons. Therefore the symmetry (symmetric or antisymmetric) of the spin part of the wave function influences the symmetry of the spatial wave function and hence influences the total Coulomb energy of the electron system. The difference in energy between a two electron system with a symmetric (triplet) or antisymmetric (singlet) spin part of the wave function is referred to as the exchange energy. For example, ferromagnetism exists in some elements due the dependence of the Coulomb energy (the exchange energy) on the particular arrangement of the electrons and their spin in the 3d shell.

The concept of spin injection and accumulation is based on induced magnetization in a nonmagnetic metal. However one this description of spin injection and accumulation is only valid in the situation where a nonmagnetic metal is weakly coupled via tunnel barriers, to its electrical environment [22].

So-called magnetic discrete alloys todays are of the most prospective materials for solution of the spin injection problem. These alloys involve a periodic system of sub-monolayers of magnetic ions (for example, Mn), placed between semiconducting layers (GaAs, GaSb, InAs) forming a magnetic superlattice. There are as incidentally distributed Mn ions and 2d magnetic islands of MnAs (or MnSb) as well in manganese containing layers. The discrete alloys have high Curie temperatures (above 300 K for the GaSb-system), demonstrate extraordinary Hall Effect at high temperatures and have a relatively high degree of the spin polarization. It is possible in such systems to control not only quality of the border "ferromagnetic metal - non-magnetic semiconductor", but also manage of the current carrier's concentration and change the type of magnetic ordering. The discrete alloys should be considered as random magnet systems owing to hardly inhomogeneous allocation of a magnetic phase in sub-monolayers [23].

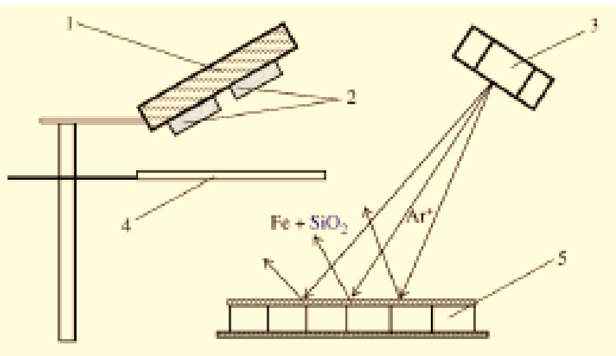


Figure 6. The scheme of the setup for composite film deposition by ion-beamsputtering of the compound target: (1) substrate holder with heater, (2) substrate, (3) ion-beam source, (4) shutter and (5) target

Operation of a spintronic device requires efficient spin injection into a semiconductor, spin manipulation, control and transport, and spin detection. The relevant role in solution of this problem is shunted to search and investigations of new ferromagnetic materials, which are capable to be reliable and good spin injectors. Among such objects the magnetic discrete alloys are very promising. They are multilayer systems composed of submonolayers of a ferromagnetic material in the matrix of a non-magnetic semiconductor, for example, Mn/GaAs or Mn/GaSb. It is well known, that these alloys have high Curie temperatures and sufficiently high spin polarization. The circumstance is not less important that it is possible to control and to manage of the "ferromagnetic metal - semiconductor" boundary surface immediately during the synthesis of these materials. As it was investigated recently they should be prepared by the methods of the MOS hydride epitaxy Ion beam sputtering (fig. 6) and mostly by laser epitaxy with usage of pulsed annealing of epitaxial layers [24, 25].

These technologies are rather simple and, at the same time, allow to perform the doping of layers under the over saturated condition.

The significance of spintronics is stipulated by perspectives of development and creation of new types of a non-volatile memory with random access (MRAM), quantum single-electron logical structures, and ultra dense information storage media. Thus, elementary information storage unit will be represented by an electron spin. The giant magnetoresistance effect (GMR) brightly has demonstrated, that a spin-polarized electrons can carry magnetic moment through non-magnetic materials with saving spin coherence, this is the meaning of the term “spin transport” nowadays (fig.7) [26].

The sensors operating with the tunnel magnetic junctions (MTJ) fall into the second class spintronics devices. The tunnel conductivity depends on relative orientation of the electrode magnetizations, and tunnel magnetoresistance (TMR) it is small for parallel alignment of magnetizations of electrodes and is high in opposite case. In contrast with the GMR of devices, electrodes are magnetic independent in this case and have different critical fields for changing of the magnetic moment orientation. Due to this reason, the third direction of development spintronic devices is based on the development of multilayer nano structures of ferromagnetic semiconductors, which demonstrate properties not available for their metal analogs.

Novel very exiting properties of semiconductors are determined by impurities and their disordered distribution. At the same time the last theoretical and experimental achievements have shown that disorders in semiconductors should be controlled – should have the necessary regulations [27, 28].

On the Curves of typical dependence of specific resistance from back temperature for undoped p-GaSb in temperature range of 3-77 K it is possible to underline two areas: I – in temperature range 3-10K, which is relevant to hopping conductivity, and II – in temperature range 15-77 K, which is connecting with zone conductivity and ionization of energy levels E1=0,013 eV and E2 = 0.034 eV (fig.8).

In obtained dual phase ferromagnetic GaMnSb films, regardless to the case of previously studied single phase GaMnSb systems (Curie temperatures not exceeding 30 K), the anomalous Hall effect (AHE) and the AHE hysteresis character at temperatures up to 300 K, as stronger as more the hole concentration, has been observed (Fig.2). The unusual properties of GaMnSb films have been interpreted as interaction of magnetic nanoclusters in a semiconductor matrix, where the matrix has huge concentration of free holes and magnetic ions. The interaction seems to be caused by the potential Shottky barriers at the cluster/semiconductor interface sensitive to the hole concentration in the semiconductor matrix.

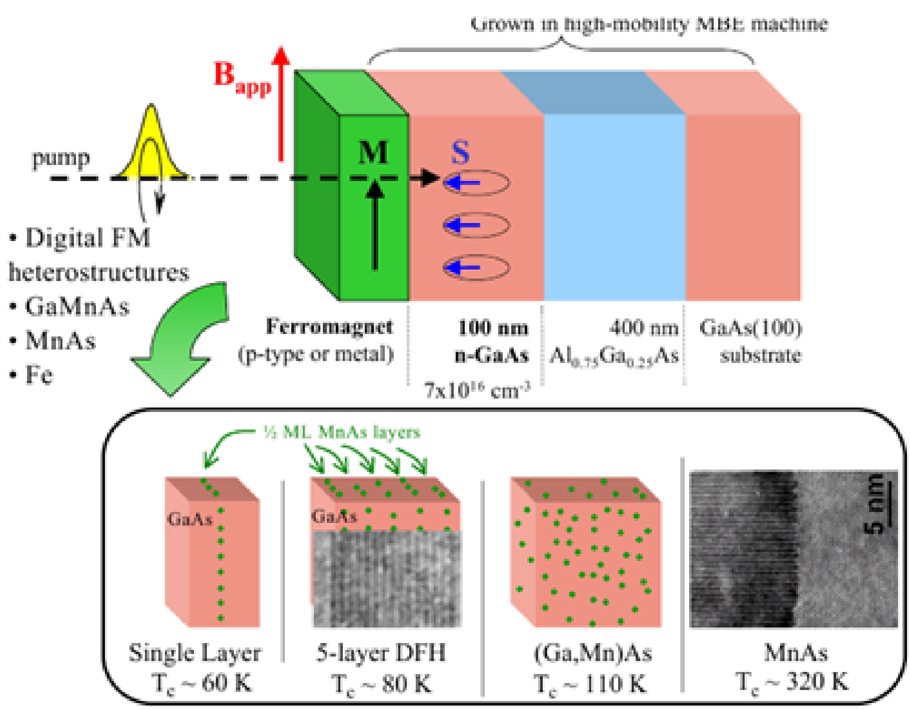
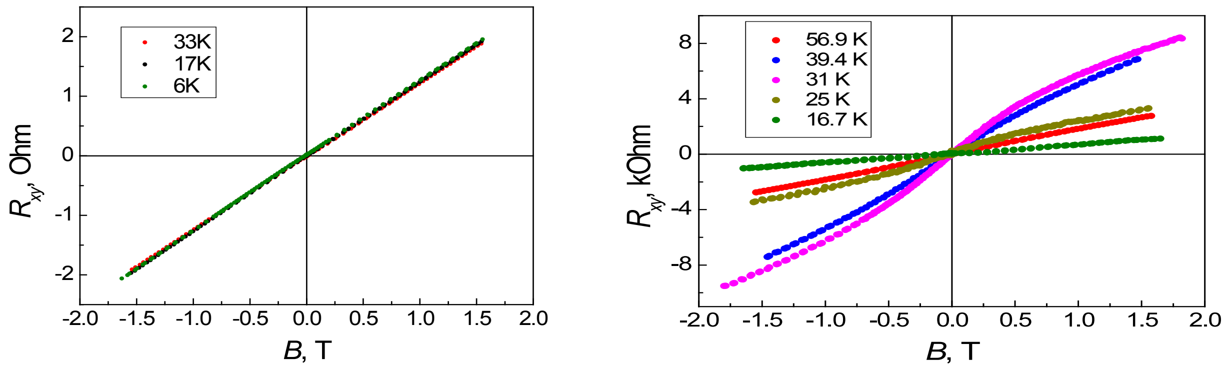


Figure 7. Electron Spin Coherence in Ferromagnet/GaAs Nanostructures [26]



(a) (b)

Figure 8. Hall effect in quantum-sized GaAs(δ-Mn)/$In_xGa_{1-x}As$/GaAs structures with metallic (a) and activation (b) type of conductivity at different temperatures [31]

Theoretical approaches developed during the last decade present invaluable tools for studying the microscopic origins of ferromagnetism and predicting electronic, magnetic and structural ground state properties of magnetic semiconductors. It is necessary to underline that the local density approximation combined with disorder averaging coherent potential approximation is very useful for studying diluted magnetic semiconductors. The effects of the AsGa – Asi – VGa transition to the ferromagnetism of (GaMn) As can be explained by the Mulliken orbital populations of the d-shell for both majority and minority spins and the corresponding spin polarization for the ferromagnetic configuration. In this case the ferromagnetic coupling is strengthening considerably by the distortion, and that all together the energy splitting and Mulliken orbital population of AsiVGa are the very similar to those of defect free (GaMn)As. These suggest that the ferromagnetic order in (GaMn)As is unaffected by the presence of AsiVGa pairs. This result is in agreement with the hole-mediated picture of ferromagnetism, and can understood by noting that AsiVGa defects energy levels show minimal splitting in (GaMn)As [29, 30].

Theoretical models of the virtual crystal approximation have been used to study the influence of the impurity disorder on transport and magnetic properties of magnetic semiconductors. The Boltzmann equation with Born approximation for scattering rates provides the estimate of Anisotropic Magnetoresistance Effect up to 12%. The key for understanding kinetic and magnetic anisotropy effects is a strong spin-orbit coupling in the semiconductor valence band. The most striking feature in off-diagonal conductivity coefficients, in (GaMn)As is the large Anomalous Hall Effect (AHE), which occurs due to the spin-orbit interaction.

One of the most suitable examples of nano and quntum effects connection is the process of the spin-polarized transport of charge in -ferromagnetic semiconductor nanolayers with controlled disorder. Operation of a spintronic device requires efficient spin injection into a semiconductor, spin manipulation, control and transport, and spin detection (fig.9). The relevant role in solution of this problem is shunted to search and investigations of new ferromagnetic materials, which are capable to be reliable and good spin injectors [32].

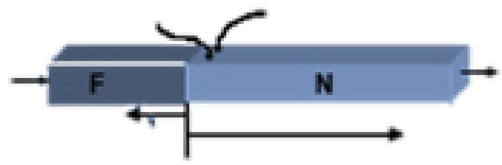


Figure 9. Schematic representation of the experimental layout for electrical spin injection: with λF and λN on either side of the F/N interface represent the distance where the spin accumulation exists in the F and N metal

Theoretical approaches developed during the last decade present invaluable tools for studying the microscopic origins of ferromagnetism and predicting electronic, magnetic and structural ground state properties of magnetic solid state materials. It is necessary to underline that the local density approximation combined with molecular cluster structures and averaging coherent disorder potential approximation is very useful for studying diluted magnetic materials.

4. Conclusions

The unique properties of well known semiconductors: Germanium, Silicon, metal oxides, etc. are reachable by precise doping of different impurities (Boron isotopes, 3d metals, etc.) makes possible to establish of different high sensitive devices, and among them gamma and neutron radiation sensors of high resolution; temperature sensors working in harsh environment; resistive nanosensors with memory, and others [33, 34].

These smart instruments should be integrated in recently developing intelligence networks including quantum information technologies based ones, which determine their high sensory characteristics and possibility of precise management and control in wide spectrum of applications.

It should be taken into account that in various conditions it is a very convenient to use the semiconductor boron and its main compounds as the sensitive elements for different types of radiation sensors as well as for sensory systems working in critical sites and harsh environment. The Boron and refractory borides which are high temperature and high resistance wide forbidden zone semiconductors and their physical properties including the variation of isotope concentration are very prospective for application in aggressive media where they are stable working elements for a long time. Besides of it they are very attractive for future developments of micro and nanosystems as the multiapplicable semiconductor elements. Above mentioned materials based sensors and sensory systemsas well as quantum effects based nanostructured magnetic solid state ones open the new ways for preparing the novel radiation sensorydevices with unique characteristics.

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