

PROSPECTIVE APPLICATION FERROELECTRIC AND SEMICONDUCTING MATERIALS IN NANOELECTRONICS

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Recent advances in the field of research in solid state physics made possible the widespread use of different dielectrics and, in particular, ferroelectrics and semiconductors in modern micro-and nanoelectronics. They are currently used as a basic material for the manufacture of small-sized ceramic capacitors with high specific capacitance, parametric amplifiers and multipliers, transmitters and receivers of ultrasonic, sonic and hypersonic oscillations modulators and detectors of optical radiation, and so on.

Physics of real crystals, ferroelectric and semiconductor materials represents one of the most important areas of development and improvement of condensed matter physics.

Ferroelectrics are crystalline substances with special dielectric and semiconductor properties, but the crystals are known to be characterized by a regular arrangement of atoms.

Many areas of application of ferroelectrics have begun to develop only relatively recently, but now they can be considered as promising. In particular, it is connected with the use of ferroelectric memory in computer systems because they, like ferrites, may be constructed with a rectangular hysteresis loop. Manufacturing ferroelectric memory array is expected to be technologically very simple, but a number of issues still remain unresolved.

Ferroelectric phase transition, spontaneous polarization is a reflection of the extraordinary pliability of the crystal lattice of ferroelectric crystals with respect to external influences. By the magnitude coefficients, characterizing this compliance, are much higher than the corresponding values for ordinary dielectrics, ferroelectrics and that makes materials for applications in various fields of modern technology of promising.

From the standpoint of practical application versatility at present among moment of semiconductor materials solid micro-and nanoelectronics can be distinguished silicon carbide - a material having an extremely broad set of useful properties: electro-optical, strength, corrosion-resistant. Wide band gap, the possibility of obtaining the material with electron and hole conductivity, high chemical stability determine the prospects for its use in devices with electron-hole transitions, capable of operating at high temperatures, with a high stability of their properties along period of for time.

The most studied system of solid solutions of silicon carbide is the $(\text{SiC})_{1-x}(\text{AlN})_x$ structure. Silicon carbide (SiC) and aluminum nitride (AlN) form a continuous series of solid solutions $(\text{SiC})_{1-x}(\text{AlN})_x$ with the band gap of 3.35 to 6.2 eV. The proximity of the values of the lattice parameters and thermal expansion coefficients of SiC and $(\text{SiC})_{1-x}(\text{AlN})_x$ produces heterostructures based on their basis with minor defects at the heterojunction.

The possibility of significant (as much) change in the band gap E_g in solid solutions of aluminum nitride in silicon carbide, as well as resistance to high temperature, radiation, chemical and mechanical effects makes these materials promising for creating solid nanoelectronics devices operating in extreme conditions.

When creating microsystems for various functional purposes on the basis of composite materials the following criteria must be taken into account: crystal chemical and thermomechanical compatibility; thermal, electrical and mechanical resistance. The most important are hybrid systems, which along with silicon and other semiconductor materials used polymers, ceramics and metals. Taking into consideration possible peculiarities of their functioning (high temperatures, aggressive media, radiation) the «silicon carbide - aluminum nitride» $(\text{SiC})_{1-x}(\text{AlN})_x$ combination is of great interest as the basic medium of materials science. The composition combines two wide-material, one of which - the aluminum nitride - is a pronounced dielectric and piezoelectric properties has good and the other - silicon carbide, is a wide-gap semiconductor. Both are active optically, including the ultraviolet spectrum area have a high Debye temperature and thermal conductivity, which characterizes resistance of the material to the external effects (thermal, chemical, radiation).

Thus, the above analysis showed that the thermal and electrical properties of silicon carbide and solid solutions based on it make these materials promising for the development of solid-state devices nanoelectronics.