PERSPECTIVE MATERIAL FOR PHOTO ENERGY

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Abstract: *in article perspective material for photo energy on the basis of silicon is considered. The paper proposes a scientifically grounded, fundamentally new approach to managing the fundamental parameters of the basic material of electronics and silicon photovoltaics. The essence of the proposed approach is the formation of binary elementary cells and their associations of different composition, structure and concentration in the silicon lattice with the participation of atoms III and V of the group. It is shown that the most suitable pairs of atoms of groups III and V allow us to obtain a new class of silicon-based material with unique functionality for optoelectronics and photovoltaics.*
Keywords: *photo energy, silicon, material, electronics, solar technology, energy, cage, structure, structure, concentration, grid, atom, group, element, cell, temperature, semiconductor.*

ПЕРСПЕКТИВНЫЙ МАТЕРИАЛ ДЛЯ ФОТОЭНЕРГЕТИКИ

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Аннотация: *в статье рассматривается перспективный материал для применения фотоэнергетики на основе кремния. Работа представляет с научной точки зрения обоснованный, существенно новый подход к управлению фундаментальными параметрами основного материала электроники и кремниевой гелиотехники. Сущность предложенного подхода - формирование двойных элементарных клеток и их ассоциации различного состава, структуры и концентрации в кремниевой решетке с участием атомов III и V из группы. Показано, что самые подходящие пары атомов групп III и V позволяют нам получать новый класс основанного на кремнии материала с уникальной функциональностью для оптоэлектроники и гелиотехники.*
Ключевые слова: *фотоэнергетика, кремний, материал, электроника, гелиотехника, энергия, клетка, состав, структура, концентрация, решётка, атом, группа, элемент, ячейка, температура, полупроводник.*

The main problem facing modern photovoltaics is an increase in the efficiency of silicon photo cells, it is this factor that determines prices and large-scale ground-based use of them in photovoltaics. The main reason for this is not the participation in the photo generation of a significant part of the solar IR radiation in the region λ=1,15÷3 μm, which is about 40% of the solar radiation, and also the inefficient use of photon energy from the energy hν>Eg, which leads to effect of thermalizes, i.e. to the deterioration of the parameters of the photocells. According to the authors of [1], in optical silicon cells optical losses associated with the above effects are about 50%.

However, the existing technology and functionality of semiconductor materials, including silicon, which is now widely used in photovoltaics, do not allow finding a solution for the above problems. And the recent use of multistage photocells based on semiconductor compounds $A^{III}B^{V}$ [2] cannot substantially solve the problem of large-scale use of such photocells in terrestrial conditions due to rather complicated technological conditions of their manufacture and high cost of such structures.

Therefore, a successful solution of this problem requires the substantiation of the physical foundations and the development of technological conditions that allow the spectral region of silicon sensitivity to be expanded both in the direction of the IR region and in the direction of the visible and UV spectral regions. In this paper we proposed an original solution to this problem, consisting in a substantial expansion of the spectral region of silicon sensitivity, as a result of the formation of fundamentally new elementary cells involving atoms of groups III and V in the silicon lattice. It should be noted that such new elementary cells act as a new class of quantum structures with unique and yet unexplored functionalities with a controlled composition, structure, concentration, and distribution in the silicon lattice.

As is known, the elements of III and V groups in silicon under the condition of doping separately are mainly located at the sites of the crystal lattice, form solid substitutional solutions and act as donors and acceptors, respectively (figure 1). Therefore, these impurities are technological impurities and are widely used in the preparation of both n- and p-type conductivity materials with different resistivities.

Studies carried out over the last 10-15 years show [3-5] that the most effective way of forming clusters of impurity atoms, including binary ones, is low-temperature doping with subsequent heat treatment under certain thermodynamic conditions, depending on the nature of the impurity atoms. In contrast to traditional high-temperature diffusion, as well as epitaxial methods, the proposed method allows the maximum participation of impurity atoms in the formation of binary elementary cells with a controlled structure, composition, concentration and distribution in the silicon lattice. A high solubility and sufficiently low diffusion coefficient of the elements of groups III and V in silicon provide a layer of the necessary thickness enriched in such cells in the volume of the crystal, i.e. the problem of obtaining a new class of a volume-ion-siliconized material with controlled parameters is practically solved.

To form new elementary cells, the atoms of groups III and IV should be adjacent and occupy two adjacent site positions in the silicon lattice, forming electrically neutral molecules ($A^{+}_{III}B^{-}_{V}$), which are the basis for new yet unexplored elementary $Si_2A^{+}_{III}B^{-}_{V}$ (figure 1).

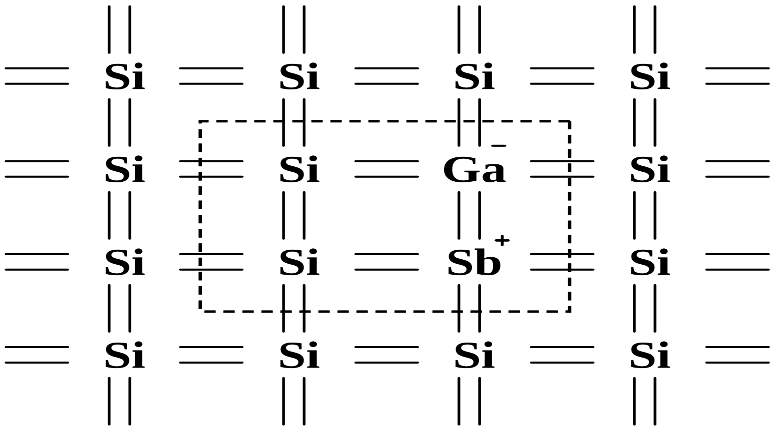

Fig. 1. New cell of $Si_2Ga^-Sb^+$ ($Si_2A^{III}B^V$) in silicon

In such cells there will be a partially-ionic covalent bond formed by such lattices practically does not violate the tetrahedral bond and they form part of the crystal lattice of silicon. This provides a more advantageous thermodynamic state of the system, which stimulates self-organization, self-restructure and the formation of other new elementary cells. As the results of the study showed, with the increase in the concentration of impurity atoms introduced, molecules are formed with the formation of more complex structures (figure 1), eventually forming nuclei of a new phase of the semiconductor compound, i.e., formation of nanocrystals of semiconductor compounds $A^{III}B^{V}$ in the silicon lattice. Since the newly formed nanostructures are in the silicon lattice, the fundamental parameters of silicon with such nanostructures differ significantly not only from the fundamental parameters of silicon, but also from the corresponding semiconductor compounds $A^{III}B^{V}$, which is a unique feature of such materials.

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