Trigonal Jahn-Teller complex V_{Ga}-Te_{As} in GaAs

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For a number of deep centers in semiconductor crystals of cubic symmetry, the electron-phonon interaction qualitatively rearranges the electronic and spatial structure[1]. The effective interaction of charge carriers localized on the defect with vibrations of the lattice atoms closest to the impurity ion leads to a strong static Jahn-Teller effect and the appearance of several equivalent configurations, in each of which the symmetry of the complex is lowered compared to the initial cubic one. However, in semiconductors, the formation of complex defects is possible, which, in addition to the impurity ion, may contain vacancies in the main lattice. In this case, the initial symmetry of the complex will be reduced, but remain high enough to exist degenerate orbital states for electrons. The report studies a defect that appears in cubic GaAs when doped with Te and S donors . The impurity complex contains an impurity and a vacancy in the main lattice in place of As, so that the initial symmetry is trigonal, with the main axis parallel to {111}. The complexes under study give photoluminescence bands with a quantum energy less than the band gap. This made it possible [2] to establish, on the basis of measuring the degree of linear polarization of photoluminescence in the presence of uniaxial deformation along various directions and the degree of linear polarization in the case of resonant polarized excitation, that V_{Ga}-Te_{As} and V_{Ga}-S_{As} have monoclinic symmetry and there are three equivalent configurations, the transition between which is possible at low temperatures. An analysis of the entire set of experimental data made it possible to conclude that the impurity complexes under study are anisotropic reorienting defects subject to a strong static Jahn-Teller effect. Since the initial symmetry of the complex is C_{3v}, then there is an (A+E)*e problem, which includes the pseudo effect JT as well.[3]. The value of the vibronic coupling constants depends on the charge state of the complex; in the emitting state, 6 electrons are localized on the defect, and in the absorbing state, 7 electrons. As a result, the static effect of JT in the emitting state is stronger than in the absorbing state, and reorientation occurs precisely in the absorbing state. Comparison with experimental data made it possible to estimate the heights of barriers between equivalent states and the displacements of atoms from lattice sites and other parameters.

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[2] A.A.Gutkin ,N.S. Averkiev, Semiconductors 56,779 (2022)
[3] I.B.Bersuker ”The Jahn-Teller Effect” Cambridge University Press (2010)