2005 Vol.44 No.2 pp.375-380 DOI:

Electronic and Shallow Impurity States in Semiconductor Heterostructures Under an Applied Electric Field

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(Received: 2005-1-5; Revised: 2005-3-17)

Abstract: With the use of variational method to solve the effective mass equation, we have studied the electronic and shallow impurity states in semiconductor heterostructures under an applied electric field. The electron energy levels are calculated exactly and the impurity binding energies are calculated with the variational approach. It is found that the behaviors of electronic and shallow impurity states in heterostructures under an applied electric field are analogous to that of quantum wells. Our results show that with the increasing strength of electric field, the electron confinement energies increase, and the impurity binding energy increases also when the impurity is on the surface, while the impurity binding energy increases at first, to a peak value, then decreases to a value which is related to the impurity position when the impurity is away from the surface. In the absence of electric field, the result tends to the Levine's ground state energy (-1/4 effective Rydberg) when the impurity is on the surface, and the ground impurity binding energy tends to that in the bulk when the impurity is far away from the surface. The dependence of the impurity binding energy on the impurity position for different electric field is also discussed.

PACS: 73.21.Fg, 71.55.Eq
Key words: heterostructures, electric field, impurity states

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