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材料合成及性能

导带弯曲对有限深$GaN/Ga_{1-x}Al_xN$球形量子点中束缚极化子的影响及其压力效应

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摘要： 采用三角势近似界面导带弯曲,研究了有限高势垒$GaN/Ga_{1-x}Al_xN$球形量子点中束缚极化子的结合能及其压力效应。数值计算了杂质态与声子之间相互作用对结合能的影响,同时与方形势垒进行了比较。结果表明,随着电子面密度的增加,导带弯曲效应增强,束缚极化子结合能逐渐下降。当电子面密度$n_s=(6.0,8.0)\times10^{11}/cm^2$且量子点半径$R>10$ nm时,束缚极化子的结合能趋近于一个相同且较小的值。结合能的极化效应主要来自杂质与光学声子相互作用的贡献。

关键词： 量子点　束缚极化子　电子面密度

Effect of Band Bending on The Bound Polaron in A $GaN/Ga_{1-x}Al_xN$ Spherical Finite-potential Quantum Dot Under Pressure

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Abstract: The bound polaron in a $GaN/Ga_{1-x}Al_xN$ spherical finite-potential quantum dot under hydrostatic pressure is investigated by using a triangular potential to approximate the band bending of the interface potential. We performed numerical calculation on the binding energy of the electron-phonon and ion-phonon interactions. The binding energy of a bound polaron is compared with the case of square potential. The results show that the binding energy of bound polaron decreases with the increasing of electron areal density. We observed that the binding energy closes to the different values of electron areal density $n_s=(6.0, 8.0)\times10^{11}/cm^2$ when the dot radius $R>10$ nm. The ion-phonon interactions play a major role in the polaronic effect.

Keywords: quantum dot　the bound polaron　electron areal density

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参考文献：

[1] Mora-Ramos M E, Lopez S Y, Duque C A. A variational method for the description of the pressure-induced Γ-X mixing in GaAs-based quantum wells [J].Phys. E.2008, 40(5):1212-1213
[2] Helm M, Peeters F M, De Rosa F, et al. Far-infrared spectroscopy of minibands and confined donors in $GaAs/Al_xGa_{1-x}As$ superlattices [J].Phys. Rev. B.1991, 43(17):13983-13991
[3] Correa J D, Porras-Montenegro N, Duque C A. Binding energy and photoionization cross-section in GaAs quantum well-wires and quantum dots: Magnetic field and hydrostatic pressure effects [J].Braz. J. Phys.2006, 36(2A):387-390
[4] Kasapoglu E, Yesilgul U, Sari H, et al. The effect of hydrostatic pressure on the photoionization cross-section and binding energy of impurities in quantum-well wire under the electric field [J].Phys. B.2005, 368(1-4):76-81
[5] Li S S, Xia J B. Electronic states of a hydrogenic donor impurity in semiconductor nanostructures [J].Phys. Lett. A.2007, 366(1-2):120-123
[6] John P A. The effect of hydrostatic pressure on binding energy of impurity states in spherical quantum dots [J].Phys. E.2005, 28(3):225-229
[7] Porras-Montenegro N, Pérez-Merchancano S T. Binding energies and density of impurity states in spherical GaAs-GaAlAs quantum dots [J].J. Appl. Phys.1993, 74(12):7624-7626
[8] Vartanian A L, Vardanyan L A, Kazaryan E M. Hydrogenic impurity bound polaron in a cylindrical quantum dot in an electric field [J].Phys. Lett. A.2007, 360(4-5):649-654
[9] Huangfu Y F, Yan Z W. Bound polaron in a spherical quantum dot under an electric field [J].Phys. E.2008,

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40(9):2982-2987

[10] Zher Samak, Bassam Saqqa. The optical polaron versus the effective dimensionality in quantum well systems [J]. An-Najah Univ. J. Res. (N.Sc.), 2010, 24(1):55-70.

[11] Melnikov D V, Fowler W B. Electron-phonon interaction in a spherical quantum dot with finite potential barriers: The Fr hlich Hamiltonian [J]. Phys. Rev. B, 2001, 64(24):5320-5328.

[12] Kandemir B S, Altanhan T. Polaron effects on an anisotropic quantum dot in a magnetic field [J].Phys. Rev. B.1999, 60(7):4834-4849

[13] Comas F, Trallero-Giner C. Interface optical phonons in spherical quantum-dot/quantum-well heterostructures [J].Phys. Rev. B.2003, 67(11):115301-115307

[14] Satori H, Sali A, Satori K. Polarizability of a polaron in spherical quantum dots [J].Phys. E.2002, 14(1-2):184-189

[15] Zhang M, Yan Z W. Interface effect on the impurity state in a GaN/$Ga_{1-x}Al_xN$ quantum dot under pressure [J]. Chin. J. Lumin.(发光学报), 2009, 30(4):529-534 (in Chinese).

[16] Cao Y J, Yan Z W. Effect of band bending on the impurity state in GaN/$Al_xGa_{1-x}N$ spherical finite potential quantum dot under pressure [J]. J. Inner Mongolia University, 2013, 44(1):36-42.

[17] Sing J. Quantum Mechanics [M]. New York: Wiley-Inter Science Publication, 1997.

[18] Platzman P M. Ground state energy of bound polarons [J].Phys. Rev.1962, 125(6):1961-1965

[19] Ting D Z Y, Chang Y C. Mixing in GaAs/$Al_xGa_{1-x}As$ and $Al_xGa_{1-x}As$/AlAs supperlattices [J].Phys. Rev. B.1987, 36(8):4359-4374

[20] Yan Z W, Ban S L, Liang X X. Effect of electron-phonon interaction on surface states in zinc-blende GaN, AlN, and InN under pressure [J].Eur. Phys. J. B.2003, 35(1):41-47

[21] Goni A R, Syassen K, Cardona M. Effect of pressure on the refractive index of Ge and GaAs [J].Phys. Rev. B.1990, 41(14):10104-10110

[22] Shi L, Yan Z W. Exciton in a strained (001)-oriented zinc-blende GaN/$Al_xGa_{1-x}N$ ellipsoidal finite-potential quantum dot under hydrostatic pressure [J].Phys. Stat. Sol. C.2011, 8(1):42-45

[23] Sadeghi E. Impurity binding energy of excited states in spherical quantum dot [J].Phys. E.2009, 41(7):1319-1322

[24] Christensen N E, Gorczyca I. Optical and structural properties of III-V nitrides under pressure [J].Phys. Rev. B.1994, 50(7):4397-4415

[25] Bose C, Sarkar C K. Binding energy of impurity states in spherical GaAs/$Ga_{1-x}Al_xAs$ quantum dots [J].Phys. Stat. Sol. (b.2000, 218(2):461-469

[26] Zhao G J, Liang X X, Ban S L. Binding energies of donors in quantum wells under hydrostatic pressure [J].Phys. Lett. A.2003, 319(1-2):191-197

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