Theoretical Treatment of the Resonant Hyper-Raman Scattering in $A^2B^6$ Semiconductors

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In this work the theoretical treatment of the hyper-Raman scattering (HRS) of light by LO-phonons is given for $A^2B^6$ semiconductors of the wurtzite structure, taking into account the complex top valence band which consists of the three closely-lying doubly degenerate subbands. The intermediate virtual states of an electronic system are assumed to be the Wannier excitons. For the considered crystals the wavefunctions of the relative motion of an electron and a hole satisfy the system of the effective mass approximation (EMA) equations which can be become the hydrogen-like equations under some assumptions. With the use of the perturbation theory the terms associating the EMA equations for the different subbands and anisotropy of the exciton effective mass tensor can be taken into account. In this work the wavefunctions and the energy for the lowest ($n = 1$) states of three excitonic series were obtained in a first approximation. Owing to the known zone structure and the symmetry selection rules the nonzero effective mass parameters for the hexagonal $A^2B^6$ crystals were found. It is shown that for the scattering geometry $z(xx, x + z)y$ the HRS mechanism including the two-photon dipole transition to the lowest excitonic state of the A series gives a contribution to the cross section only when allowance is made for the first order corrections. Rough estimations have shown that this can lead to an added feature on the frequency dependence of the HRS cross section under condition of the two-photon resonance with the lowest exciton state of the A series.

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