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Two-mode Jahn-Teller effect in the absorption spectra of Fe^{2+} in II-VI and III-V semiconductors

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Abstract

Coupling of acoustical and optical modes is introduced to interpret zero-phonon lines in extended absorption spectra of Fe^{2+} in binary compounds of local symmetry T_d. Both cubic II-VI (CdTe, ZnTe, ZnSe, ZnS) and cubic III-V (GaAs, InP, GaP) compounds are included in analysis and calculations. For the case of ZnS:Fe^{2+}, which plays an important role here, interesting experiments are reported. The interpretation of the low-temperature absorption spectra of the seven systems unfolds generalities so all observed lines, as well as the absence of some expected lines, can be identified in the same generic way. In fact, only one parameter is freely varied, which is the coupling constant to one optical mode (additional to the usual acoustical one) which is necessary to explain high-energy lines. The general and consistent explanation of several lines for seven different systems provides a complete picture which allows a deep understanding of vibronic coupling to Fe^{2+} in binary compounds. The values of coupling constants explaining the experiments are tabulated.

Keywords: Jahn-Teller effect, II-VI semiconductors, III-V semiconductors, iron, phonons