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Calculation of Effective Masses and Curie Temperature of (Ga, Mn) as Diluted Magnetic Semiconductor from the Eight-band k.p Model

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Abstract : The discovery of a dilute magnetic semiconductor (DMS) in which ferromagnetism is carrier-mediated and persists above room temperature is a major step toward the implementation of spintronic devices for processing, transferring, and storing of information. Among the many types of DMS materials which have been investigated, Mn-doped GaAs has become one of the best candidates for technological application. However, despite major developments over the last few decades, the maximum Curie temperature (~200 K) remains well below room temperature. In this work, we have studied the effect of Mn content and strain on the GaMnAs effective masses of electron, heavy and light holes calculated in the different crystallographic direction. Also, the Curie temperature in the DMS GaMnAs alloy is determined. Compilation of GaMnAs band parameters have been carried out using the 8-band k.p model based on Lowdin perturbation theory where spin orbit, sp-d exchange interaction, and biaxial strain are taken into account. Our results show that effective masses, calculated along the different crystallographic directions, have a strong dependence on strain, ranging from -2% (tensile strain) to 2% (compressive strain), and Mn content increased from 1 to 5%. The Curie temperature is determined within the mean-field approach based on the Zener model.

Keywords : diluted magnetic semiconductors, k.p method, effective masses, curie temperature, strain
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