Possible Donor and Acceptor Levels for Muonium in ZnSe

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Alternative sets of transition assignments are discussed for muonium in weakly n-type ZnSe. The transition energies from ionization processes are associated with thermodynamic donor and acceptor levels for Mu in ZnSe and therefore can provide an experimental model for the defect levels of hydrogen. The primary experimental data related to the Mu donor state comes from microwave resonance data taken at TRIUMF which identifies the neutral signal labeled as Mu_{II} as an immobile Mu^0 center located in the T-site with Se neighbours. This resonance signal amplitude decreases below 50 K, but reappears above 200 K. The eventual disappearance of the Mu_{II} signal near 350 K shows two characteristic energies, which can be associated with electron ionization and a competing Mu^0 site change to T_{Zn}, although the final-state site is not proven experimentally. We can thus place a Mu donor level associated with the T_{Se} site in ZnSe at $\sim$ g.41 eV below the conduction band minimum. This donor level may need some adjustment because T_{Se} is a metastable location for both Mu^0 and Mu^+; however, any shift involves only the difference in site metastability for these two charge-states. There are two transitions that we currently consider to be candidates for possible assignment to an ionization process from which the acceptor level position could be obtained. One of these occurs at low temperatures with an initial state that is Mu^t in our present model and the second possibility occurs at high temperatures to a diamagnetic final state, thus Mu^t if associated with the acceptor level. The relevance for an overall model of hydrogen in semiconductors if either of the characteristic energies for these transitions can be unambiguously assigned to the Mu acceptor level will be briefly discussed.