Calculation of formation-time of impurity centers in crystals with diamond lattice structure induced by negative muons

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Study of semiconductors and insulators by means of negative muons (μSR-technique) gives good additional possibilities for study some acceptor centers. Indeed, negative muon implanted into a lattice is captured by one of the host atom. The lowest energy level of the muonic atom has a characteristic radius at 207 times smaller, than Bohr's radius. So, a nuclear with an effective charge Z-1 is appeared and an impurity similar to an acceptor center is formed. The μSR-technique gives possibility to study hyperfine interactions and kinetics of this impurity in a lattice. All hyperfine structure constants of Al impurity in Si were measured in μSR-experiments earlier. But an interpretation of experimental results strongly depends on a state of the impurity under examination when kinetic processes are studied. In particular it is very important to know a formation-time of the impurity in the ground state. We assume that deep energy levels of the impurity are filled in at very short atomic time, and total formation-time is determined by a neutralization stage and a capture of "the last" electron for formation an acceptor impurity center. The neutralization stage of the impurity formation is conditioned by radiation processes and characterized by a time of $\leq 10^{-9}$c. This time slightly depends on atomic number of host atoms. After the stage of neutralization we have a situation, when one of chemical bonds for the nearest neighbour of the muonic atom is broken. This chemically active center captures additional electron from a valence zone and forms bound state with a hole as an acceptor center. This process is accompanied by an optical phonon emission and strongly differs for diamond, Si and Ge crystals. Obtained results are very useful for the interpretation of the recent μSR-experimental data in diamond.