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Lattice location of implanted transition metals in 3C-SiC

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SiC is a wide band-gap semiconductor with several decades of material research and device development in high-power electronics with commercially successful applications. Transition metals (TM) impurities are invariably found in bulk samples of SiC due to the production processes normally employed. It is known that those impurities, either in their isolated form or when in complexes with other defects, generate electrically active levels deep in the band gap of SiC, changing its electrical properties and thus affecting the performance of devices. Currently hardly any experimental data exist on the preferential lattice sites that TM impurities occupy in any of the SiC polytypes.

We have investigated the lattice location of implanted 56Mn, 59Fe and 65Ni transition metals (TMs) in undoped single-crystalline cubic 3C-SiC by means of the emission channeling technique using radioactive isotopes produced at the CERN-ISOLDE facility. We find that in the room temperature as-implanted state the majority of Mn, Fe and Ni occupy the carbon coordinated tetrahedral interstitial sites (TC). Smaller TM fractions were also found on the Si substitutional (SSi) sites. The TM atoms partially disappear from ideal-TC positions during annealing at temperatures between 500 ℃ and 700℃ which is accompanied by an increase in both the TM fraction occupying the SSi sites and on random sites. An explanation is given according to what is known about the annealing mechanisms of silicon vacancies in silicon carbide. The origin of the observed lattice sites and their changes with thermal annealing are discussed and compared to the case of Si, highlighting the feature that the interstitial migration of TMs in SiC is much slower than in Si.

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