Atomic structure and Electrical Property Study on Indium implanted Germanium

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We present a lattice configuration and electrical properties study on In doped Ge by high energy ion implantation in a range of concentrations. Using Extended X-ray Absorption Fine Structure (EXAFS) experiment in Australian Synchrotron, and results simulated in FEFF 8.4 code, we find that In atoms occupy a substitutional site in Ge crystal structure when In concentration is below 0.3 at. %; and then In precipitates and form In metal nanoparticles from 1 at. %, and the coordination number of Ge first shell bonding with substitutional Indium begins to decrease and In-V (indium - vacancy) complex is predicted. Similar phenomena is observed in In doped Si samples, for concentration lower than 1.85e19 atoms / cm^3, In atoms occupy the substitutional position in Si lattice with highly disordered Si lattice surrounding, when concentration is above or equals to 1.85e19 atoms/cm^3, Indium metal nanoparticles appear.

X-ray Absorption Near Edge structure (XANES) spectra are also analysed, simulations are performed on both FEFF9 and FDMNES code with the Muffin-Tin Potential Approximation, both simulations agree with the experimental results and support the model introduced in EXAFS simulations. Hall Effect measurements are applied to investigate conductivity, carrier's density and Hall mobility of the implanted samples; the samples' electrical properties are with their calculated atomic structures. TEM (Transmission Electron Microscopy), Raman Spectroscopy and RBS/C (Rutherford Back Scattering / Channelling) are also applied, and results agree well with XAS.