Characterization of lattice defects by positron annihilation spectroscopy

Jakub Čížek
Faculty of Mathematics and Physics, Charles University

Positron, i.e. an antiparticle of electron, can be used as an excellent probe of open volume lattice defects in solids. A positron implanted into a solid is delocalized in the lattice and can be confined in open volume defects, e.g. vacancies, vacancy clusters, dislocations, grain boundaries etc. Since positron is delocalized in the lattice as a modulated Bloch-like wave it actively 'seeks' for defects. As a consequence positron annihilation spectroscopy provides extremely high sensitivity to open volume defects. Positrons in solids are annihilated by electrons and the annihilating electron-positron pair is converted into two annihilation gamma rays which can be detected and carry information about the annihilation process. There are two principal observables related to positron annihilation: (i) positron lifetime and (ii) Doppler shift in the energy of annihilation radiation. Positron lifetime spectroscopy enables to identify type of defects in samples and to determine their concentration. Coincidence Doppler broadening carries information about the local chemical environment of defects. Positron annihilation parameters can be calculated from the first principles and calculated data can be directly compared with experiment. Comparison of positron annihilation data and *ab-initio* modelling of defects enables to determine the actual configuration of defects in solids on the atomic scale. In the present talk the principle of positron annihilation techniques will be explained and some examples of positron annihilation study of metallic and semiconductor materials will be provided.