DETECTOR RESOLUTION IN POSITRON ANNIHILATION DOPPLER BROADENING EXPERIMENTS

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Positron annihilation Doppler broadening spectroscopy is one of the most popular positron annihilation vacancy characterization techniques. It gives information about the chemical environment surrounding an atom-scale vacancy in the form of electron momentum distribution. It is sensitive to very low vacancy concentrations, which makes it an important and interesting method especially in semiconductor research [1].

The measurements are often conducted in a slow positron beam setup, which enables depth profiling of the samples. The key measurement devices of Doppler broadening spectroscopy setups are high-purity germanium detectors, with which the Doppler shifted annihilation gammas are measured. Doppler broadening spectroscopy is one of the standard techniques in defect characterization, thus there is a demand to evaluate different factors that might have an effect on the results.

The energy resolution of a germanium detector is generally considered very stable although very sensitive to external disturbances like tremor. In a modern functional germanium detector with accurate pulse shaping, the main statistical error in the signal originates from discrete charge generation in the germanium crystal. However, the energy resolution deteriorates on the edges of the crystal, and this makes the total energy resolution of the detector dependent on the measuring geometry [2]. How much can the effects on the edges change the total energy resolution of the germanium detector in experiments? What is the relevance of the measurement geometry in Doppler broadening experiments? Do the vacuum materials placed in between the detector and the sample change the radiance geometry and the measurement results?

We have considered answers and perspectives to these questions based on Monte Carlo simulations and experiments. In the simulations, the MCNP code is applied for the modelling of photon-detector interactions and the Doppler broadening spectrum is obtained from *ab initio* theoretical calculations of the electron-positron momentum distribution in silicon [3, 4].

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