Doppler broadening experiments (and calculations) in β-Ga_2O_3: vacancy defects, signal anisotropy, or both?

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We have applied slow positron beams and fast positron spectrometers with the intention to study vacancy-type defects in a wide variety of β-Ga_2O_3 materials: unintentionally doped and Si and Sn doped hetero- and homo-epitaxial thin films grown by metal-organic chemical vapor deposition (MOCVD) and halide vapor phase epitaxy (HVPE), as well as Mg, Fe and Sn doped bulk crystals grown by the Czochralski (CZ) and edge film-fed growth (EFG) methods. The data can usually be interpreted as the presence of varying concentrations of Ga vacancy related defects in some of the samples [1]. However, the colossal anisotropy of the positron annihilation signals makes quantitative interpretations cumbersome, as the magnitude of the anisotropy is comparable to the changes produced by annihilation at vacancy defects (compared to the annihilations in the "perfect" lattice) [2]. We report on a detailed experimental and theoretical investigation of the positron annihilation signals in β-Ga_2O_3 and provide an approach for identifying different kinds of vacancy defects based on the signal anisotropy. Interestingly, it appears that bulk-like positron signals might not be observed in any of the studied β-Ga_2O_3 samples.

References

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