BOOK OF ABSTRACTS FROM THE INTERNATIONAL WORKSHOP ON POSITRON STUDIES OF DEFECTS 2024 (PSD-24)

The International Workshop on Positron Studies of Defects 2024

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Variability in FeB Pair Association Rates in Silicon under Ultrasound Loading: Effects of Acoustic Wave Types

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Ultrasound (US) is recognized as an effective tool for defect engineering in materials science. Its broad utility stems from the ability to modify both the frequency and type of acoustic waves, allowing for a targeted approach to specific defect types. Recent studies [1,2] have demonstrated that US loading can force an increase in the association rate of FeB pairs in Cz- silicon solar cells, likely due to a lowered energy barrier (ΔE) for iron ion migration. The magnitude of acoustically-induced (AI) energy reduction ΔE_{US} is foreseeably dependent on the intensity of the excited acoustic waves (see Figure 1) and can reach up to 15 meV. Further research revealed an intriguing frequency effect associated with acoustic wave types. Specifically, when FeB complex is stimulated by longitudinal waves of a constant intensity, the value of ΔE_{US} rises with frequency (Fig. 1, left panel). In this scenario, an increase in acoustic vibration frequency leads to a remarkable decrease of efficiency in the interaction of the acoustic wave with the defect. In contrast to this picture, when transverse ultrasonic waves are excited, the opposite effect is observed: higher frequencies enhance the efficiency of forming the FeB complexes (Fig. 1, right panel). Such behavior of the FeB center in Si under ultrasound loading distinctly demonstrates the presence of an anisotropic deformation field ambient the defect [1], and, similar to the other positron-sensitive centers in the diamond-like semiconductors (see, e.g., [3]), the oversized ion core of atom of Fe may manifest itself in emitting the element-specific annihilation radiation. Such feature is promising to enable identification of FeB complex to be recognized in its energetically anisotropic reaction to acoustic oscillations depending on wave type. Being regarded as an effective positron trap, FeB center will be considered for studying by the positron annihilation under US loading conditions to verify predictions concerning its microstructure.

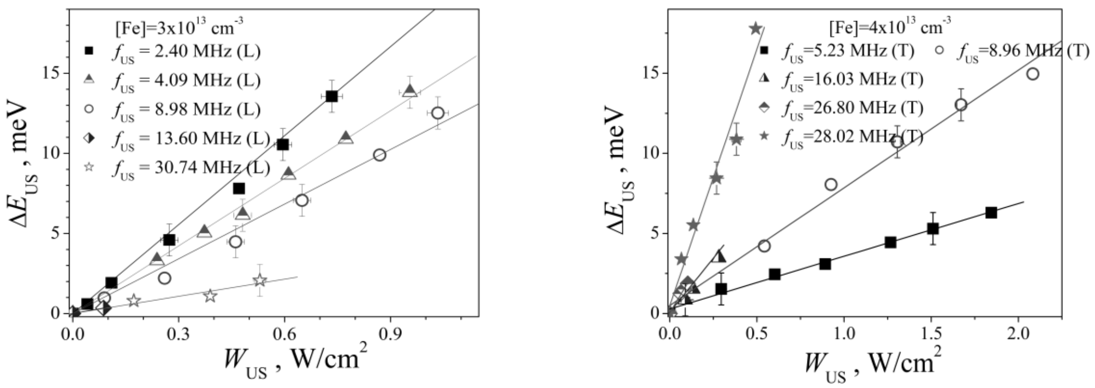

Figure 1: Dependencies of acoustically induced changes in iron ion migration energy on ultrasound intensity using longitudinal (L, left panel) and transverse (T, right panel) acoustic waves of different frequencies.

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