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The Possible Effect of Crystal Defects in Hot Carrier Solar Cells

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Hot Carrier Solar Cell (HCSC) classified as a promising concept for energy losses reduction in solar cells. Ross and Nozik suggested that a hot-carrier solar cell (HCSC) may be producing efficiency of up to 85% [1] by providing energy conversion efficiency more than traditional Si solar cells [2]. The hot carrier solar cell (HCSC) purposes to tackle the carrier thermalisation loss after absorption of above band-gap photons. The primary mission of the hot carrier absorber is reducing the cooling rate of carrier at least 100s of picosecond but if possible, ns to be like the rate of radiative recombination. Also, the hot carrier is usually cooling by the emission of LO phonons [3]. It is known that polycrystalline semiconductors are affected by grains and defects that reduce solar cell efficiencies but their effect on hot carrier properties is not known. This paper will review the possible effect of crystal defects in hot carrier solar cell (HCSC).

The crystal defects like point defects, line defects and surface defects playing a vital role in V_{oc} by acting as Shockley-Read-Hall nonradiative recombination centres leading to short minority carrier lifetime and minimised V_{oc} value [4]. Each level of defects providing an alternative mechanism for recombination. According to the Fermi level position, the level of crystal defects could donate/accept electrons [4]. Crystal defects like dislocations, strain-induced and crystal aggregation have significant effects on the optical properties [5]. In addition, low crystal quality causes strain-induced defects which affect optical properties and the hot carrier analysis [3]. CIGS has unique properties that led to a large amount of defects, like grain boundaries and electrostatic-potential fluctuation. It is noted that the state of defects below the band gap affecting luminescence processes and carrier relaxation for this material, this can be observed from the excitation intensity dependence [6]. The quantum confinement in nanostructures is characterised by strain-induced defects, non-ideal recombination pathways and heterojunctions [7]. The level of defects increases the hot carrier loss process at the QD/cap interface [7]. The longer of radiative recombination is affected by GaAs thickness quality leading to observation more hot carrier radiative lifetimes [3]. The importance of crystal defects and polycrystallinity on hot carrier lifetime will be discussed.

References

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