

Influence of monolayer AlAs on solar cells with InAs quantum dots embedded in InGaAs/GaAs matrix

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Using quantum dots (QDs) in active layers is attractive due to their potential applications in photoelectronic devices. The ability to tune QD density, size, and chemical composition is very useful to cover the desired spectral region.

In studies dealing with InAs QDs, an annealing procedure is often used. During annealing of InAs QDs at relatively high temperatures a combination of ripening and InAs decomposition happens. The size and chemical composition of QDs can be tuned without formation of defects [1]. However, segregation of In has to be considered. The segregation of In affects the performance of the devices. For suppression of In segregation, a thin AlAs capping layer was introduced [2].

To understand the influence of such a monolayer on devices, we fabricated multilayer solar cells with InAs QDs covered by 1 monolayer AlAs. The device structure is shown schematically in Fig. 1. The devices with and without AlAs capping layers are compared and characterized by atomic force microscopy (AFM), illuminated *J-V* curves and photocurrent measurements, respectively.

AFM images, as shown in figure 2, indicate that the device without AlAs layers has holes on it. The formation of holes is most likely due to In segregation [2]. In the *J-V* curves, the open-circuit voltage of the device with AlAs layers is higher than the one without AlAs layer, indicating a possible connection between holes and lower open-circuit voltage.

Although the bandgap of AlAs is larger than that of GaAs, using a thin AlAs cap minimizes the reduction of current while improving the open-circuit voltage.

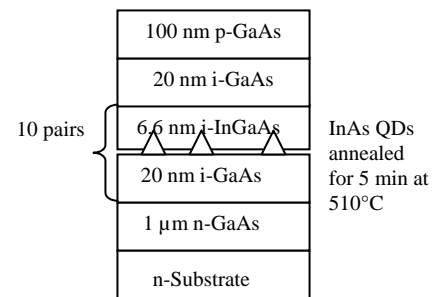


Fig. 1. Device structure. Two devices are fabricated with and without 1 monolayer AlAs layer on top of InAs QDs.

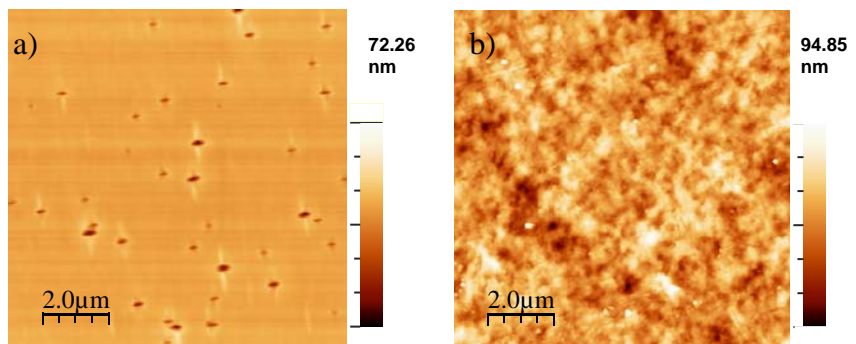


Fig. 2. AFM images of surfaces. a) without AlAs layers, b) with AlAs layers

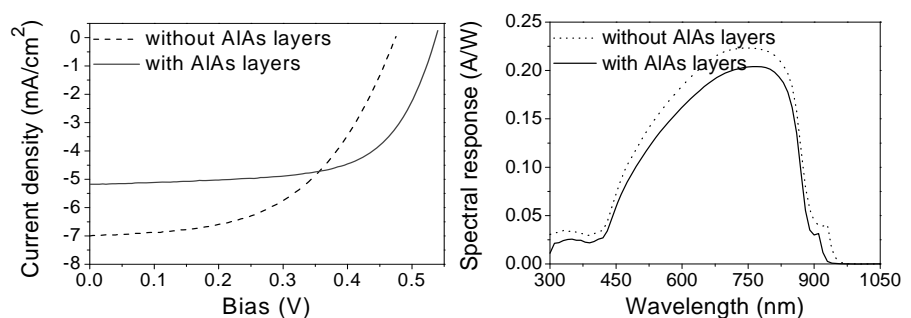


Fig. 3. *J-V* curves and photocurrents.

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