A path toward 25%-efficient ultrathin GaAs solar cells

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Saving scarce materials and reducing the cost are key issues for the development of photovoltaics, notably to contribute to industrial throughput improvements. However, reducing the absorber thickness usually comes at the expense of light absorption. Therefore, a light-trapping strategy is required to compensate for the low single-pass absorption in very thin films. Fabricated with a low-cost nanoimprint lithography process, a TiO_2/Ag nanostructured mirror was designed at the rear side of the solar cell enabling multiple overlapping resonances. Recently, thanks to this design, we have achieved a record 19.9%-efficient GaAs solar cell with an absorber thickness of only 205 nm, using a broadband light trapping based on multi-resonant absorption (Fig. 1(a)) [1] . Enhancing the performance of this ultrathin device is our main objective.

In this contribution, we will present a detailed optical and electrical loss analysis of the ultrathin GaAs cells. Transport properties can be further optimized with a slightly modified design of the front contact grid, minimizing the series resistance. In regards to optical losses, the nanostructures metallic reflector undergoes parasitic absorption which reduces the efficiency of the device. Using the Rigorous Coupled Wave Analysis (RCWA) method, we have redesigned the architecture of the rear-side mirror and achieved an increase of 2.16 mA/cm^2 of the theoretical current density (Fig. 1(b)). We will present our latest experimental results carried out to compensate for the mentioned losses.

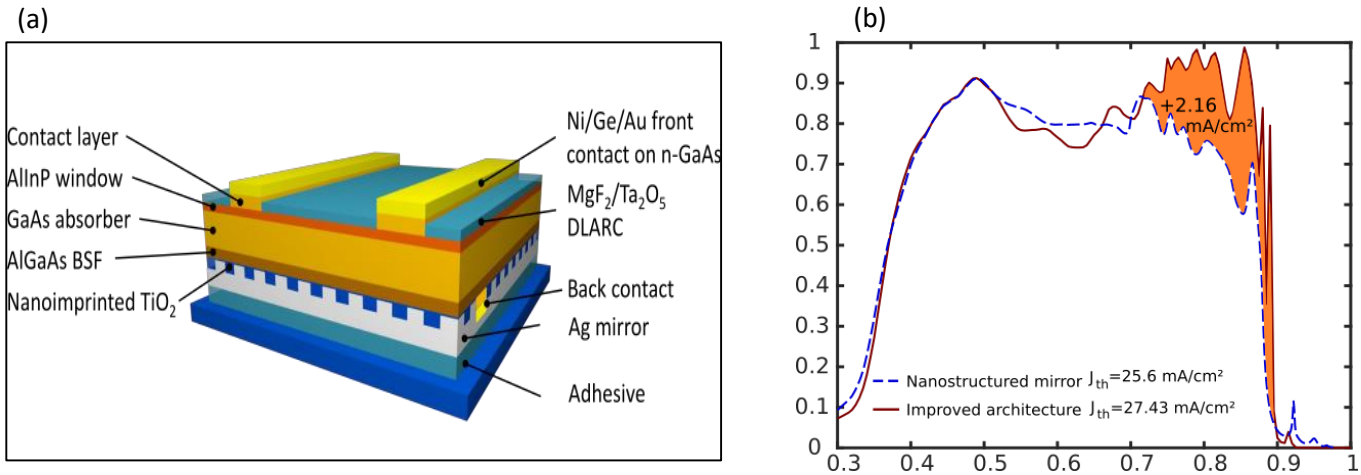

Figure 1 : (a) Schematic illustration of the record 19.9%-efficient GaAs solar cell structure. (b) Calculation of absorption in 205 nm GaAs with a nanostructured mirror and with an improved design of the rear side mirror.

[1] H. Chen *et al.*, "A 19.9%-efficient ultrathin solar cell based on a 205-nm-thick GaAs absorber and a silver nanostructured back mirror," *Nat. Energy*, **4**, 761–767, 2019.