

Efficient ultrathin GaAs solar cells with a nanostructured back mirror

Hung-Ling Chen¹, Romaric De Lépinau¹, Nicolas Vandamme², Julie Goffard¹, Benoît Behaghel¹, Christophe Dupuis¹, Nathalie Bardou¹, Aristide Lemaître¹, Andrea Cattoni¹, Stéphane Collin^{1,2}

¹Centre de Nanosciences et de Nanotechnologies (C2N), site de Marcoussis, CNRS, 91460 Marcoussis

²Institut Photovoltaïque d'Ile-de-France (IPVF) – Antony

E-mail : hung-ling.chen@lpn.cnrs.fr

Record single-junction solar cells are made of 1-2 μm thick GaAs absorbers with short-circuit current (J_{sc}) close to 30 mA/cm^2 . A thinner absorber would lead to rapid crystalline growth and potential cost-reduction. However, efficient light-trapping is needed to maintain high optical absorption over the whole solar spectrum, and the solar cell architecture has to be revised for optimal charge collection in ultrathin layers.

We investigate 200 nm thick GaAs solar cells with a nanostructured back mirror. They exhibit broadband multi-resonant absorption. We have carried out numerical calculations based on RCWA in order to explain the physical origin of resonant modes and to optimize the structure. We predict J_{sc} up to 26 mA/cm^2 . A V_{oc} improvement is also expected thanks to photon recycling effect. This project is in collaboration with Fraunhofer ISE for providing high quality GaAs epitaxial layers by MOCVD.

The nanostructured silver back mirror is fabricated by Nano-Imprint Lithography (NIL), and combined with localized ohmic contacts to ensure efficient charge collection while keeping the high reflectance of the silver back mirror. The GaAs solar cells are subsequently transferred on a glass substrate. We have measured record J_{sc} up to 24 mA/cm^2 , and conversion efficiency of 17%. It is the best performance for solar cells with thickness less than 300 nm.

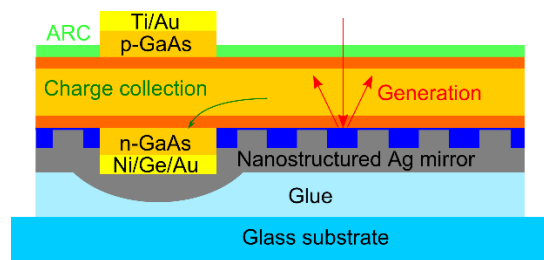


Figure 1: Structure of fabricated ultrathin GaAs solar cells

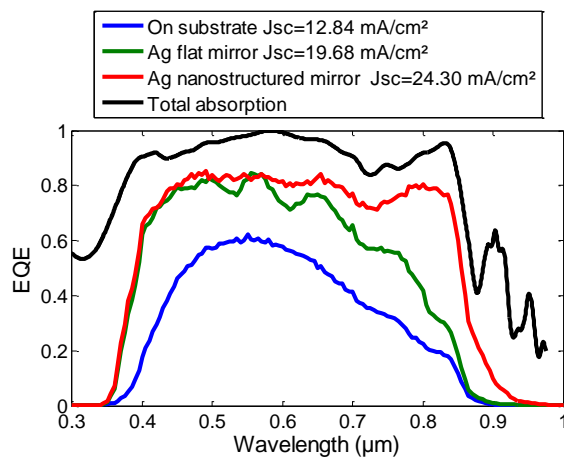


Figure 2: EQE measurement

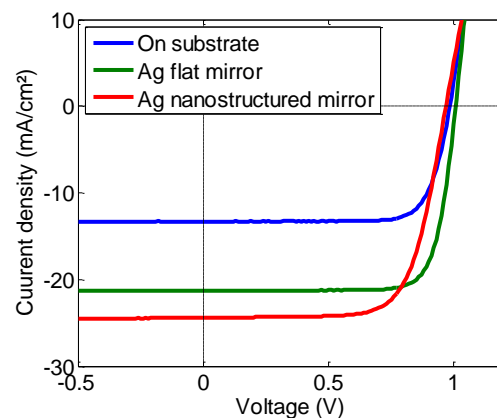


Figure 3: IV measurement under 1sun illumination