# High performance nanostructured Silicon heterojunction for water splitting on large scales


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In past years the global demand for energy has been increasing steeply, as well as the awareness that new sources of clean energy are essential. Photo-electrochemical devices (PEC) for water splitting applications have stirred great interest, and different approach has been explored to improve the efficiency of these devices and to avoid optical losses at the interfaces with water. These include engineering materials and nanostructuring the device's surfaces [1]- [2]. Despite the promising initial results, there are still many drawbacks that needs to be overcome to reach large scale production with optimized performances [3]. We present a new device that relies on the optimization of the nanostructuring process that exploits suitably disordered surfaces. Additionally, this device could harvest light on both sides to efficiently gain and store the energy to keep the photocatalytic reaction active.

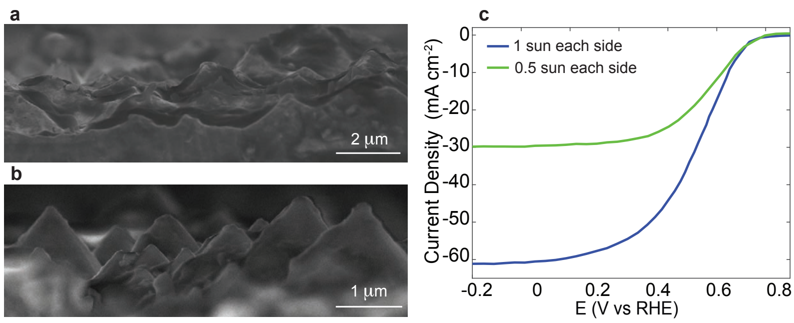


Fig. 1. (a) and (b): SEM cross sections of top and rear optimized surface of the device, (c) J-E curve of $Si/Pt$ photocathode under different illumination intensities.

Parallel FDTD simulations are carried out by our dispersive FDTD code NANOCPP [4]- [5]. Starting from an existing device, we considered two different types of interfaces: water/Si/Pt interface and water/$SiN_x$/$Al_2O_3$/Si. Optimized geometrical parameters for these surfaces are computed in order to obtain very high broadband absorbance without generating trapping state for light or carriers, thus remarkably reducing optical losses. We then realize a new device exploiting the results of our theoretical investigation. Figure 1 a-b show SEM images of the fabricated sample. Figure 1 c presents the J-E characteristic of the Si-photoelectrode under two different illumination intensities, used to provide an electrochemical characterization of the performances of the device. Once the device is illuminated, we measured a current of 60 $mAcm^{-2}$ with bias voltages V near zero. This technique could pave the way to the development of a new generation of high performance, eco-friendly and cost effective water splitting PEC devices.

## References


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