

## **Popular scientific abstract**

Solar devices made from organic material are gaining increased attention, compared to their inorganic counterparts, due to their promising advantages, such as transparency, flexibility, ease of processing etc. But their efficiencies cannot be compared to the inorganic ones. Boosting the efficiency of organic solar cells (OSCs) by nanopatterning has thus been puzzling many researchers within the past years and various methods have been proposed to be used as efficient nanostructures for OSC devices such as, plasmonic structures, nanowires (NWs), gratings, nanorods etc. The nanostructuring methods applied though, do not offer the possibility of a cheap, rapid, reproducible and scalable fabrication.

This work shows the fabrication of nanostructures via a rapid, inexpensive, easily replicable and scalable technique using porous anodic alumina (PAA) templates. PAA templates, is a well-established method for obtaining nanostructures of tailored dimensions on a large scale. Yet being a novel patterning method, its abilities are not fully explored. In this context, the basic parameters that affect the formation of PAA templates and their underlying patterned Al surface were investigated. Control of the anodization parameters allows control over the dimensions of the structures and therefore easy control of the underlying dimples dimensions.

Experimental and theoretical studies of the Al dimple nanostructures have revealed field-enhancement at the ridges of the Al dimples, a valuable effect for OSC devices. To enhance the usability of etched PAA templates for nanostructuring, imprinting of the structures was investigated, using flexible PDMS stamps. Imprinted dimple structures revealed an increase in absorption and efficiency enhancement in P3HT:PCBM BHJ devices. Not limited to this, imprinting of the organic layer of P3HT:PCBM and imprinted ridges, are additional applications of the imprinting process presented.

Such patterning methods, together with the analysis of the dimples' properties in this work, contribute in the improvement of the imprinting processes of nanostructures for organic solar cell applications.