Resonant Photocurrent Generation in Dye-Sensitized Periodically Nanostructured Photoconductors by Optical Field Confinement Effects

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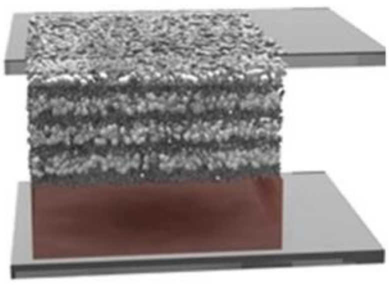
Abstract

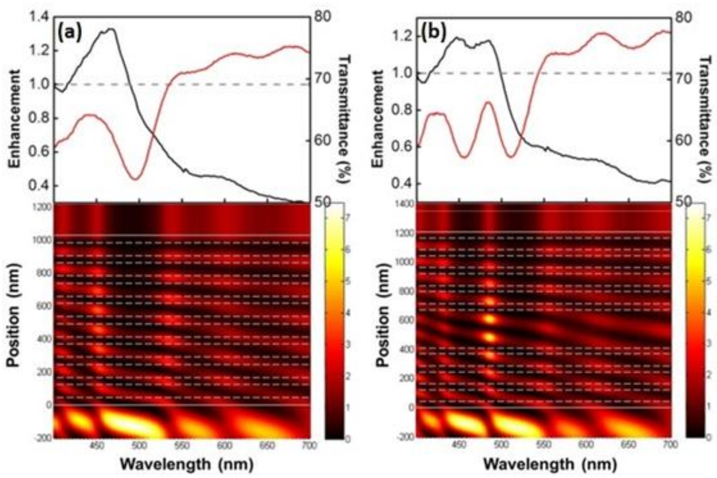
Herein we show experimental evidence of resonant photocurrent generation in dye sensitized periodically nanostructured photoconductors. These materials were attained by the alternating deposition of layers of TiO_2 nanoparticles with different porosity to produce a spatial modulation of the refractive index in one dimension of the space.[1] We have built both periodic and broken symmetry nanostructured photoconducting TiO_2 multilayers with enough number of periods as to display different types of photon resonances that confine the field within the material in different ways. The resonant photocurrent finds their foundations in light confinement effects that were achieved by spectral matching of the sensitizer absorption band to different types of localized photon modes present in either periodical or broken symmetry structures. Results are explained in terms of the calculated spatial distribution of the electric field intensity within the configurations under analysis.[2] Such simulations were performed using a code written in MatLab and based on the transfer matrix method. A direct relation between resonant photon modes and photon-to-electron conversion peaks can be established. We foresee this sort of structures could allow the development of photo-electro-chemical devices with finer spectral control over light absorption.

References

[1] Calvo, M.E.; Colodrero, S.; Rojas, T.C.; Anta, J.A.; Ocaña, M.; Míguez,H.; Adv. Func. Mater., 18 (2008), 2708-2715.
[2] Anaya, M.; Calvo, M.E.; Luque, J.M.; Míguez, H., J. Am. Chem. Soc. (2013), DOI: 10.1021/ja401096k.

Figures





Left: System design. **Right:** Spectral variation of the photocurrent enhancement factors for (a) periodic arrangement of layers and (b) a resonator built by depositing a thicker middle layer within a periodic multilayer (black solid lines). The respective transmittance spectra are also plotted (red solid lines). In the bottom panels, the calculated spatial distribution of the electric field along a cross section of both types of structures is plotted as a function of the incident wavelength.