Up-conversion and down-shifting in sol-gel derived glass-ceramics containing rare-earth doped SnO_2 and LaF_3 nanocrystals

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The increase in the efficiency of solar cells is a challenge issue at present in the race for sustainable renewal energy sources against climate change. It is known that the limited spectral response of commercial semiconductor solar cells to the wide solar spectrum constitutes the main cause of losses in photovoltaic technology [1, 2]. That is why the efficiency of current solar cells could be appreciably increased by means of up-conversion and down-shifting processes which convert photons from the NIR and UV-blue, respectively, into the green-red, where the solar cell response be maximum. These effects could be obtained by means of luminescence layers without interfering with the active material [3].

Here we report a novel class of nanostructured glass-ceramics comprising two co-existing rare-earth doped nanocrystalline phases, SnO_2 semiconductor nanocrystal (quantum dot) and LaF_3, embedded into a silica glass matrix for an efficient simultaneous UV and IR to visible photon conversion. On one hand, the wide and strong UV absorption by SnO_2 quantum dot and subsequent efficient energy transfer to Eu^{3+} [4] and, on the other hand, the also very efficient IR to visible up-conversion with the pair Yb^{3+}-Er^{3+} partitioned into low phonon LaF_3 nanocrystalline environment, yield to visible emissions with application in improving the spectral response of photovoltaic solar cells.

References

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Figures