Visible to near-infrared upconversion emission of highly content Er^{3+}-doped fluoroindate glasses and glass/polymer composites for solar cells applications

Tarcio C. Silva*, Danilo Manzani, Sidney J.L. Ribeiro

Institute of Chemistry, São Paulo State University (UNESP), Araraquara, Brazil.

*e-mail: tarciosabbath@hotmail.com

Solar cell (SC) is the most deployed technology to convert sunlight energy to electricity. One of the most drawbacks to harnessing sunlight is the solar spectrum mismatch. Silicon SC with a band-gap of 1.12 eV can only absorbs wavelength range between 250 and 1100 nm. Photons with higher wavelength than 1100 nm is lost by transmission, due to their low energy. This means that these photons cannot be used in the generation of photocurrent. A viable alternative to overcome this drawback is the use of lanthanide-doped materials, which convert infrared radiation to visible light through up-conversion (UC) mechanisms. Over the past few decades, many reports have suggested improvements in the photocurrent by placing an UC material over a bifacial solar cell. Among lanthanides ions, erbium (Er^{3+}) is the most used one owing to its absorption at 1540 nm and emission at visible and near-infrared (NIR) range by UC effect. This UC radiation emitted matches with silicon SC absorption, then, an additional photocurrent is expected to appear. In this work, we present results on UC luminescence of Er^{3+}-doped fluoroindate glasses, which were prepared by the conventional melting-quenching method. A great intense emission at visible and NIR region were obtained under excitation at 1500 nm. In order to apply this luminescent glass for photovoltaic application, we evaluated the feasibility by using a composite material composed by glass and polymer, making the material flexible, lightweight and functional. A commercial silicon SC cell was used to evaluate the photocurrent increase by placing the Er^{3+}-doped glass over it and exciting the system at 1500 nm. A maximum photocurrent of 22 μA is observed to sample with higher Er^{3+} amount and no photocurrent is observed when the samples was removed under the commercial silicon SC. This result suggest a great potentiality to use glasses for photocurrent increase in SC. Furthermore, for the best of our knowledge, was prepared a lightweight and flexible composite film of glass/polymer, which also exhibited UC luminescence with potential application for photovoltaic devices that operate using absorbing bilayers.

References

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