EMCMRE-1
Marrakech-Morocco
November 21-25 2011

First Euro-Mediterranean Conference on Materials and Renewable Energies (EMCMRE-1) 21-25 November 2011

Modification Of The Solar Spectrum For Increasing The Photovoltaic Solar Cells

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Abstract:

Great progress has been achieved during recent years to improve the conversion efficiency of silicon photovoltaic solar cells. This efficiency is however still relatively low due to the mismatch between sunlight spectrum and the spectral response of the cells. One of the ways to increase this efficiency is to modify the solar spectrum by using rare earth doped luminescent materials[i]. These materials will absorb the near UV or/and blue light and transform these lights into light around 1000 nm which is very efficiently converted into electricity. The rare earth ion Yb^{3+} is generally selected as emitting ion with efficient emission around 980 nm.

Ideally, the absorbing ion should absorb strongly light in the near UV/blue region and its dexcitation should excite 1 or more Yb^{3+}, giving quantum efficiency higher than 100%. This quantum cutting mechanism has been demonstrated by using Pr^{3+}/Yb^{3+} in fluoride crystals[ii].

In this work, we have used different rare earth ion combinations including Er^{3+}/Yb^{3+} and Pr^{3+}/Yb^{3+} in different hosts. Sulphide glasses and glass ceramics present the advantages of low phonon energy, leading to high quantum efficiency. In addition, the absorption coefficient of rare earth ions is much stronger in this kind of covalent materials compared to the ions in ionic compounds such as fluoride. The preparation methods, thin film deposition and luminescent properties including quantum efficiency measurement will be presented.

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[i] B.S. Richards, Enhancing the performance of silicon solar cells via the application of passive luminescence conversion layers, Solar Energy Materials & solar cells, 90 (2006) 2329-2337

[ii] Bryan M. van der Ende, Linda Aarts, and Andries Meijerink, Near-infrared quantum cutting for photovoltaics, Advanced Materials, 21 (2009) 3073-3077