World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:10, No:06, 2016

Rare-Earth Ions Doped Zirconium Oxide Layers for Optical and Photovoltaic Applications

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Abstract : Oxide layers doped with rare-earth (RE) ions in optimized way can absorb short (ultraviolet light), which will be converted to visible light by so-called down-conversion. Down-conversion mechanisms are usually exploited to modify the incident solar spectrum. In down conversion, multiple low-energy photons are generated to exploit the energy of one incident high-energy photon. These RE-doped oxide materials have attracted a great deal of attention from researchers because of their potential for optical manipulation in optical devices (detectors, temperature sensors, and compact solid-state lasers, light-emitting diodes), bio-analysis, medical therapy, display technologies, and light harvesting (such as in photovoltaic cells). The zirconium dioxide (ZrO2) doped RE ions (Eu, Tb, Ce) multilayer structures were tested as active layers, which can convert short wave emission to light in the visible range (the down-conversion mechanism). For these applications original approach of deposition ZrO2 layers using the Atomic Layer Deposition (ALD) method and doping these layers with RE ions using the spin-coating technique was used. ALD films are deposited at relatively low temperature (well below 250°C). This can be an effective method to achieve the white-light emission and to improve on this way light conversion efficiency, by an extension of absorbed spectral range by a solar cell material. Photoluminescence (PL), X-ray diffraction (XRD), scanning electron microscope (SEM) and atomic force microscope (AFM) measurement are analyzed. The research was financially supported by the National Science Centre (decision No. DEC-2012/06/A/ST7/00398 and DEC- 2013/09/N/ST5/00901).

Keywords : ALD, oxide layers, photovoltaics, thin films
Conference Title : ICEMA 2016 : International Conference on Engineering Materials and Applications
Conference Location : Vienna, Austria
Conference Dates : June 16-17, 2016