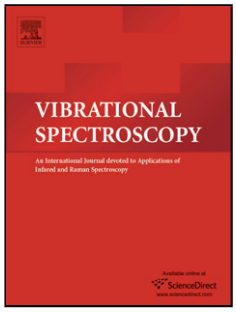

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Stability of dye-sensitized solar cell under reverse bias condition: Resonance Raman spectroscopy combined with spectrally resolved analysis by transmittance and efficiency mapping

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Abstract

In this work, resonance Raman spectroscopy (RRS) together with a spectrally resolved analysis by transmittance and efficiency mapping (SATEM) have been applied as a powerful tool to detect and to understand deeply the degradation mechanisms suffered by a series-connected dye-sensitized solar cell (DSC) in a module under real working condition. When shadowing phenomena occur on the module, the shadowed cell works as a load rather than as a generator and suffers reverse bias (RB) condition that induces a progressive degradation until the complete device's breakdown. The reported analysis follows the degradation processes involving both the electrolyte solution and the sensitizer during the aging time. In particular, polyiodides formation has been pointed out as crucial triiodide depletion mechanism in the electrolyte solution leading to a strong unbalance in the redox couple and to a slowdown in dye regeneration process. The final device breakdown occurs when hydrogen production within the electrolyte solution causes the breaking of the sealing and the partial electrolyte leakage from the active area. RRS demonstrated the irreversible structural changes suffered by dye molecules during this final stage by identifying the main degradation products. Finally, a spectrally resolved comparison between incident to photon current conversion efficiency (IPCE) for photo (PE) and counter electrode (CE) illumination were used, along with transmittance analysis, in order to derive detailed information about the structural modification suffered by the cell constituents. The combination between SATEM and RRS techniques exhaustively provided a deep comprehension of the DSC degradation processes by giving a route to further stabilize the devices for a feasible next commercialization.

Keywords: Dye-sensitized solar cells (DSCs); Resonance Raman spectroscopy (RRS); Reverse bias (RB); Degradation mechanisms; IPCE.

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