

Title : Comparative Study of Solvents in Carbon Paste on Performance of Carbon-Based Perovskite Solar Cells

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Cooperative Education (กรณี นำเสนอผลงานสหกิจศึกษา)

ABSTRACT

Perovskite Solar Cells (PSCs) have emerged as a highly promising photovoltaic technology due to their low production costs and simplified fabrication processes. A critical component influencing device performance is the electrode layer. While metal electrodes are conventionally favored, their high cost has led to extensive research into carbon-based materials as a cost-effective alternative that maintains competitive efficiency. However, traditional carbon electrode preparation methods face significant limitations; carbon paste often contains solvents and requires thermal processing that can degrade the underlying internal layers, whereas carbon sheets frequently suffer from poor interfacial contact at the hole-transporting layer (HTL)/carbon junction, leading to increased interfacial resistance and reduced device stability. This research proposes a novel approach to overcome these challenges by developing a carbon electrode prepared from carbon sheets dissolved in chlorobenzene (CB). The electrode is formed using a doctor-blading technique followed by thermal annealing under vacuum conditions. Experimental results demonstrate that carbon electrodes prepared via vacuum oven drying at 60°C for 5 minutes achieved a peak power conversion efficiency (PCE) of 11.36% (active area of 0.96 cm²), attributed to superior film continuity and

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uniform interfacial contact. Despite this success, the rapid evaporation of chlorobenzene was found to cause uneven carbon sheet dissolution, complicating the coating process. To address this, two modifications were investigated: the addition of sorbitol as a binder with carbon powder and the introduction of PGMEA (propylene glycol 1-monomethyl ether 2-acetate) as a high-boiling-point co-solvent mixed with chlorobenzene to dissolve the carbon sheets. Although both methods effectively slowed evaporation, the resulting electrodes exhibited poor electrical conductivity and a significant decline in PCE, rendering them unsuitable for electrode applications. The study concludes that carbon sheets dissolved solely in chlorobenzene remain the optimal preparation method. Comparative analysis under identical conditions revealed that the developed carbon electrode significantly outperforms traditional carbon counterparts. Specifically, the developed electrode achieved a fill factor (FF) of 60.1% and a short-circuit current density (J_{sc}) of 17.81 mA/cm^2 , markedly higher than the traditional electrode (FF = 43.75% and J_{sc} = 6.6 mA/cm^2). These findings indicate that the proposed preparation method effectively enhances the HTL/carbon interface. This novel fabrication approach provides a viable pathway for improving the efficiency and stability of perovskite solar cells in future developments.

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