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Metatitanic Acid를 광전극으로 적용한 페로브스카이트 태양전지

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염료감응형 태양전지(DSSC)는 다양한 태양전지 중, 가장 환경친화적이고, 생산단가도 낮을 뿐만 아니라 다양한 색상과 투광성을 확보할 수 있어 많은 연구가 진행되어왔다. 하지만 액체전해질을 사용하는 기존 염료감응형 태양전지는 높은 휘발성과 열 팽창 수축에 따른 전해질 누액의 문제점으로 인하여 최근에는 고체전해질을 이용한 염료감응형 태양전지의 개발이 활발히 이루어지고 있다. 또한 기존 염료보다 높은 흡광계수와 넓은 흡수스펙트럼을 지닌 페로브스카이트가 개발되어 현재 많은 관심이 주목되고 있다. 본 연구에서는 TiO_2 제조상의 중간생성물인 Metatitanic acid (MTA)를 이용하여 광전극을 형성하고 열처리 온도에 따른 나노입자의 소성거동평가을 평가하였고 시차열중량 분석, 결정상 확인을 하고 염료감응 태양전지에 적용하였다. MTA 나노입자를 Field Emission Transmission Electron Microscopy (FE-TEM), Barrett-Joyner-Halenda (BJH pore size distribution)과 Brunauer-Emmet-Teller (BET) 분석을 통해 소성거동을 평가하고, Thermogravimetry and differential thermal analysis (TG-DTA)를 통해 열중량 측정을 하였으며, X-ray Diffraction (XRD) 분석을 통해 결정상을 확인하였다. 또한 Fourier-transform infrared (FT-IR) spectroscopy를 통해 MTA 나노입자의 표면분석을 하였다. 형성된 MTA 광전극을 페로브스카이트 염료에 적용하여 5%의 효율을 달성하였다.

Keywords: perovskite, Metatitanic acid, dye-sensitized solar cells

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Importance of Green Density of Nanoparticle Precursor Film in Microstructural Development and Photovoltaic Properties of CuInSe2 Thin Films

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We demonstrate here that an improvement in precursor film density (green density) leads to a great enhancement in the photovoltaic performance of CuInSe2 (CISe) thin film solar cells fabricated with Cu-In nanoparticle precursor films via chemical solution deposition. A cold-isostatic pressing (CIP) technique was applied to uniformly compress the precursor film over the entire surface (measuring 3～4 cm2) and was found to increase its relative density (particle packing density) by ca. 20%, which resulted in an appreciable improvement in the microstructural features of the sintered CISe film in terms of lower porosity, reduced grain boundaries, and a more uniform surface morphology. The low-bandgap (Eg=1.0 eV) CISe PV devices with the CIP-treated film exhibited greatly enhanced open-circuit voltage (VOC, from 0.265 V to 0.413 V) and fill factor (FF, from 0.34 to 0.55), as compared to the control devices. As a consequence, an almost 3-fold increase in the average power conversion efficiency, 3.0 to 8.2% (with the highest value of 9.02%), was realized without an anti-reflection coating. A diode analysis revealed that the enhanced VOC and FF were essentially attributed to the reduced reverse saturation current density (j0) and diode ideality factor (n). This is associated with the suppressed recombination, likely due to the reduction in recombination sites such as grain/air surfaces (pores), inter-granular interfaces, and defective CISe/CdS junctions in the CIP-treated device. From the temperature dependences of VOC, it was confirmed that the CIP-treated devices suffer less from interface recombination.

Keywords: CuInSe2, thin-film solar cells, Cu-In, nanoparticles, packing density, cold-isostatic pressing