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ITER 톰슨산란 진단계 및 first mirror 건전성 기술 추적 및 관련 실험 진행사항

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ITER 내부 플라즈마 진단에 대한 연구는 활발히 이루어지고 있다. 그 중에서도 광학 시스템을 이용한 진단방법으로 OES, Bolometer, Stark effects, Thomson scattering이 주로 연구되고 있다. 이러한 방법을 구현하기 위해서는 핵융합로 내부에 first mirror 설치가 필수적이다. 그러나 노 내부에서 발생한 플라즈마에 의한 부식과 증착 및 광 소스에 의한 first mirror 표면 손상이 현재 ITER 주요 난제중 하나로 꼽히고 있다. 이는 추후 건설될 DEMO와 핵융합로 건설을 위해서도 필요한 연구이다. 그러나 국내에서는 이러한 연구가 거의 진행되고 있지 않다. 이에 따라 Thomson scattering 진단계와 first mirror 관련 연구동향을 추적하였다. 그리고 이 추적한 결과를 바탕으로 감마선환경에서 first mirror의 특성을 분석했다. 또한 오염 제거 및 방지를 위하여 TE(thermos-electric) 시스템을 제작하고 있다. 그리고 high energy neutral beam에 대한 플라즈마를 이용한 오염방지 실험을 진행하고 있다.

Keywords: First mirror, first mirror contamination.

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Solution processed inverted organic solar cells with hybrid inorganic/organic cathode interlayers

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In this work, we introduce a solution-processed CdS interlayer for use in inverted bulk heterojunction (BHJ) solar cells, and compare this material to a series of standard organic and inorganic cathode interlayers. Different combinations of solution-processed CdS, ZnO and conjugated polyelectrolyte (CPE) layers were compared as cathode interlayers on ITO substrates to construct inverted solar cells based on PTB7:$PC_{71}BM$ and a P3HT:$PC_{61}BM$ as photoactive layers. Introduction of a CdS interlayer significantly improved the power conversion efficiency (PCE) of inverted PTB7:$PC_{71}BM$ devices from 2.0% to 4.9%, however, this efficiency was still fairly low compared to benchmark ZnO or CPE interlayers due to a low open circuit voltage (V_{OC}), stemming from the deep conduction band energy of CdS. The V_{OC} was greatly improved by introducing an interfacial dipole (CPE) layer on top of the CdS layer, yielding outstanding diode characteristics and a PCE of 6.8%. The best performing interlayer, however, was a single CPE layer alone, which yielded a V_{OC} of 0.727 V, a FF of 63.2%, and a PCE of 7.89%. Using P3HT:$PC_{61}BM$ as an active layer, similar trends were observed. Solar cells without the cathode interlayer yielded a PCE of 0.46% with a poor V_{OC} of 0.197 V and FF of 34.3%. In contrast, the use of hybrid ZnO/CPE layer as the cathode interlayer considerably improved the V_{OC} of 0.599 V and FF of 53.3%, resulting the PCE of 2.99%. Our results indicate that the CdS layer yields excellent diode characteristics, however, performs slightly worse than benchmark ZnO and CPE layers in solar cell devices due to parasitic absorption below 550 nm. These results suggest that the hybrid inorganic/organic interlayer materials are promising candidates as cathode interlayers for high efficiency inverted solar cells through the modification of interface contacts.

Keywords: inverted, cathode interlayers, hybrid