Self-assembled monolayer as the surface passivator for efficient and stable ZnO-based perovskite solar cells

Jannatul Ferdous[1,2,3], Md. Emrul Kayesh[2], Mostafa F. Abdelbar[1], Wipakorn Jevasuwan[1], Ashraful Islam[2], Naoki Fukata[1]

[1]Research Centre for Materials Nanoarchitectonics, National Institute for Materials Science (NIMS), Tsukuba, Ibaraki 305-0044, Japan

[2]Photovoltaic Materials Group, Center for Green Research on Energy and Environmental Materials, National Institute for Materials Science (NIMS), 1-2-1 Sengen, Tsukuba 305-0047, Japan

[3]Graduate School of Pure and Applied Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan

E-mail address: fukata.naoki@nims.go.jp; islam.ashraful@nims.go.jp

Organic-inorganic perovskite solar cells (PSCs) have emerged as exciting prospects for renewable energy technology because of their high performance and low fabrication cost. An essential component of these highly efficient solar cells is the electron transport layer (ETL), which ensures selective electron contact and reduces recombination phenomena to improve device performance. Zinc oxide (ZnO) is highly regarded as a promising ETL in solar cells because of its exceptional transparency, superior electron mobility, advantageous energy level, and versatile structural properties (Figure 1).[1-2] However, the application of ZnO is currently restricted due to the adverse reverse decomposition reaction at ZnO/perovskite interfaces. The presence of surface hydroxyl groups accelerates the decomposition process.[3] This reaction greatly diminishes the efficiency of charge collection and stability of PSCs. Here we introduced a simple yet effective technique for passivating the ZnO surface using a chelating agent (polydentate ligand). The integration of the chelating agent resulted in the formation of Zinc-Polydentate ligand complex on the ZnO surface. This metal complex served as a self-assembled monolayer (SAM) and effectively passivated the ZnO surface. The utilization of chelation-processed to passivated ZnO results in the fabrication of thermally stable perovskite film with enhanced crystallinity and increased grain size (Figure 2). Consequently, the performance of the ZnO as ETL based PSC experienced a significant improvement in power conversion efficiency up to 17%.

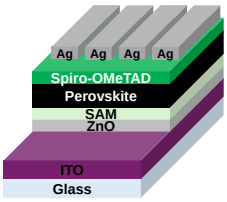

Figure 1: Schematic diagram of PSC

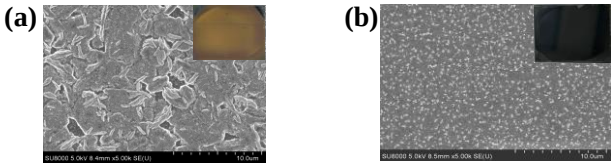

Figure 2: SEM images of perovskite film on (a) ZnO and (b) ZnO/SAM. The inset images of panels (a) and (b) show the optical images of perovskite films on ZnO and ZnO/SAM films.

References

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