Ferroelectric-semiconductor heterostructures for photovoltaic applications

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Abstract

Recently, ferroelectric materials have been considered as one of the most interesting materials for next-generation photovoltaic (PV) devices because of their outstanding advantages over conventional p-n junction based photovoltaic devices, such as their high output voltage and polarization controlled PV response [1]. However, the efficiency of light-to-electricity conversion in these materials is much less than that in the conventional solar cells due to the inefficient generation of e-h pairs [2]. One possible pathway to achieve the desired high photovoltaic efficiency is to insert a semiconductor layer in the metal-ferroelectric-metal structure, which combines advantage of the semiconductor in order to obtain a large short circuit current density (J_{sc}), and the ferroelectric for high open circuit voltage (V_{oc}) [2].
In this work, we report on the effect of the position of the ZnO layer on the photovoltaic response of the 0.5BZT-0.5BCT/ZnO heterostructure. To achieve this task, we study three types of heterostructures: Pt/0.5BCT (350 nm)/ZnO (10 nm)/ITO, Pt/ZnO (10 nm)/0.5BCT (350 nm)/ITO and Pt/ZnO (10 nm)/0.5BCT (350nm)/ZnO (10 nm)/ITO. The presence of the 0.5BZT-0.5BCT perovskite phase and the ZnO wurtzite phase was confirmed by X-ray diffraction measurements. The enhanced ferroelectric photovoltaic effect was achieved for the Pt/ZnO/0.5BZT-0.5BCT/ITO heterostructure with the V_{oc}≈-0.03 V and the J_{sc} ≈5.5 mA.cm^{-2}. The photovoltaic effect is explained in terms of the alignment of the internal electric fields and by the polarization-dependent interfacial coupling effect at the ZnO/0.5BZT-0.5BCT interface, which was confirmed by the presence of a hysteresis loop on the J_{sc} as a function of the poling voltage.

References

[1] S. Sharma, M. Tomar, A. Kumar, N. K. Puri, V. Gupta, J. Appl. Phys., **118** (2015) 074103.
[2] Z. Fan, K. Yao, J. Wang, Appl. Phys. Lett., **105** (2014) 162903.

Figures

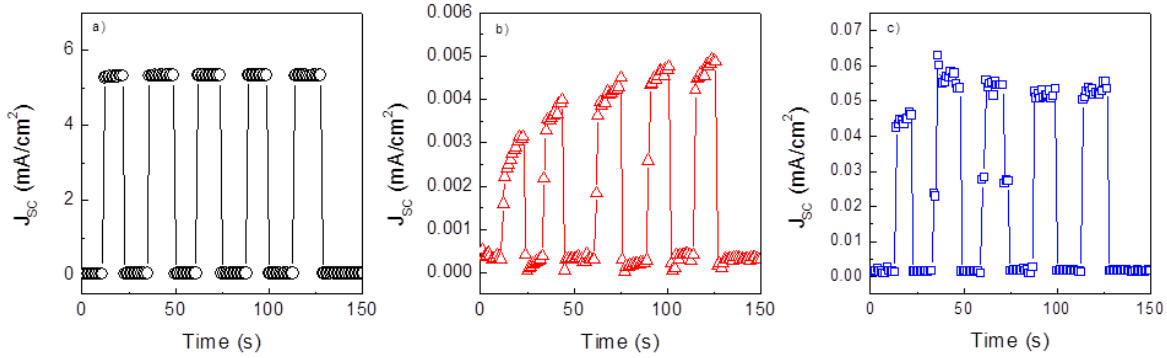

Fig 1. J_{sc} as a function of time in a) Pt/ZnO/BZT-BCT/ITO, b) Pt/BZT-BCT/ZnO/ITO and c) Pt/ZnO/BZT-BCT/ZnO/ITO heterostructures