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Ferroelectric oxide thin films for advanced energy applications

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Ferroelectrics are considered as promising photoanode materials because their high built-in-potential due to their spontaneous polarizations can largely enhance the separation and drift of photo-generated carriers. Especially, among ferroelectrics, BiFeO_3 has different spontaneous polarizations and ferroelectric domain structure depending on the crystallographic orientations, so it is of great significance to clarify the direct relationship between photocatalytic properties, spontaneous polarizations and ferroelectric domain structures. However, the photocatalytic properties of epitaxial BiFeO_3 thin film photoanodes with different crystallographic orientations and subsequently different ferroelastic domain structures have not been systematically studied yet. Furthermore, the effect of ferroelectric switching on the PEC properties of epitaxial BiFeO_3 thin film photoanodes has not been identified. Considering the above, in this study, the most enhanced photocatalytic performances of our BiFeO_3 thin film photoanodes showed in the $(111)_{\text{pc}}$ BiFeO_3 thin film photoanode, due to its high spontaneous polarization and mono-variant domain structure, which was approximately a 5.3 times larger photocurrent density at 0 V *vs.* Ag/AgCl and a 0.180 V shift in the onset potential in comparison with the $(001)_{\text{pc}}$ BiFeO_3 thin film photoanode in the downward polarization. Furthermore, ferroelectric polarization switching in the $(111)_{\text{pc}}$ BiFeO_3 thin film photoanode caused an approximate change of 8,000% in the photocurrent density at 0 V *vs.* Ag/AgCl and 0.330 V shift in the onset potential. We believe that domain-engineered ferroelectric materials can be used as an effective charge separation and collection layer for effective solar water splitting photoanodes.