Supporting Information

Enhancement of self-polarized electric field in $BaTiO_3$ thin film via europium doping and its application in improving the performance of ZnO thin film photoconductive detectors

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Experimental

Materials

All the solvents and chemicals used in the experiment were of analytical grade and used without any purification. $Ba(CH_3COO)_2$ (AR), tetrabutyl titanate (AR) and isopropyl alcohol (AR) were purchased from Macklin Shanghai. PVP 5500 (AR) was provided by Damao Chemical Reagent Factory. PVA 1788 (AR) was provided by Aladin Co. ltd. Zinc acetate dihydrate ($Zn(CH_3COO)_2.2H_2O$, AR) was purchased from the Damao Chemical Reagent Factory. $EuCl_3{\cdot}6H_2O$ was purchased from Aladin Co. ltd.

Preparation of films

The zinc oxide precursor solution was prepared by mixing 1.44 g zinc acetate dihydrate, 0.75 g PVA 1788 and 1 mL anhydrous ethanol in 19 mL deionized water. The mixture was fully stirred at 90 °C under air atmosphere for 30 minutes. For the precursor of Eu:$BaTiO_3$ film, it was mixed by two solutions. The A solution consists 1.28 g Ba $(CH_3COO)_2$, (1.83, 9.15, 18.31, 54.93 mg) $EuCl_3{\cdot}6H_2O$ and 1.8 mL DI water. The B solution is consisted of 0.04 g PVP 5500, 7.64 mL isopropyl alcohol and 1.7 mL tetrabutyl titanate. Then, these two solutions were mixed and stirred for two hours. The Eu:BTO film was prepared by spin-coating method with 300 rpm for 10 s and 5000 rpm for 20 s. After spin-coating process, the obtained samples on high-temperature resistant glass substrate were annealed in air at 800 °C for 2 h. The ZnO films were also fabricated via spin-coating technique. And the spin-coating parameters were set at 500 rpm for 10 s and 5000 rpm for 20 s.

Then, all films were annealed in air at 800 °C for 2 h.

Preparation of photodetector

After preparing ZnO film on Eu:BTO buffer layer, two sliver electrodes were dropped on ZnO film to construct photoconductive photodetector. The distance of two sliver electrodes is about 3 mm. The diameter of the silver electrode is 0.5mm

Characteristic

XRD, SEM, AFM, XPS, P-E

Photodetection performance test

I-V and I-t

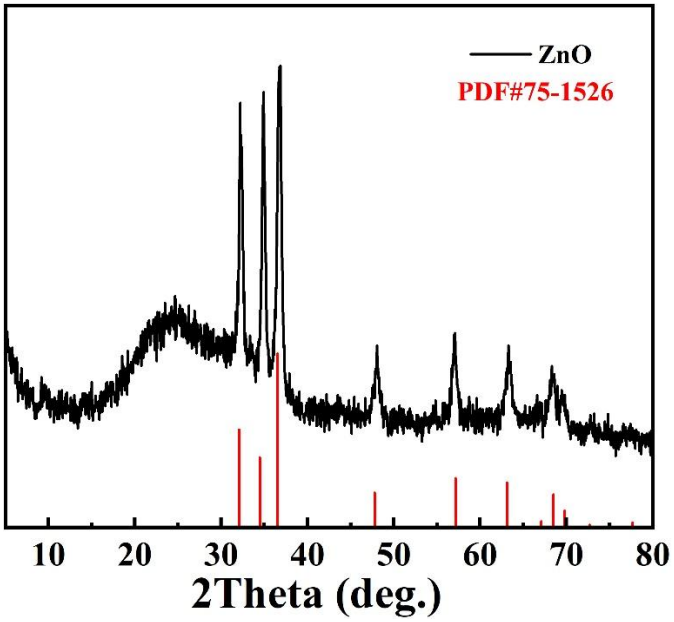

Fig. S1 XRD pattern of pure ZnO film.

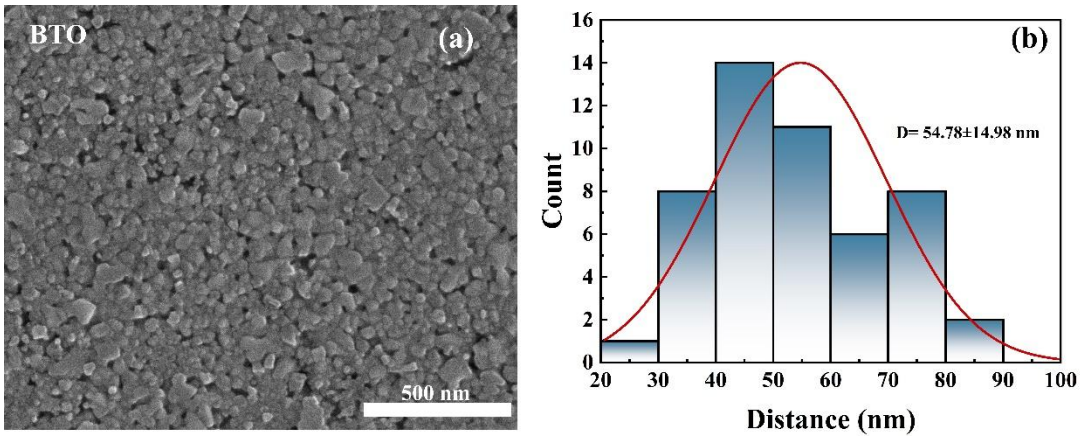

Fig. S2 Particle size statistics of pure BTO thin film.

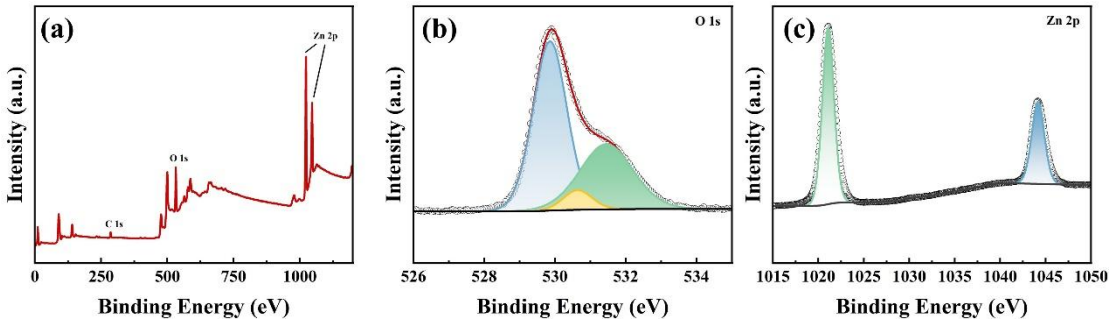

Fig. S3 (a) XPS survey spectra of pure ZnO film, and the corresponding fine spectra, (b) O 1s, (c) Zn 2p.

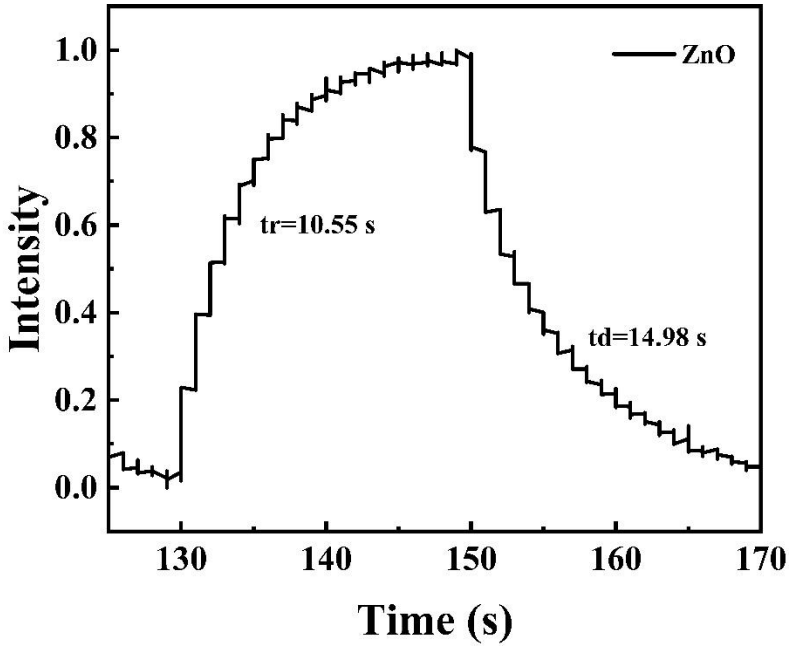

Fig. S4 Single period I-t curve of photoconductive device based on pure ZnO film.

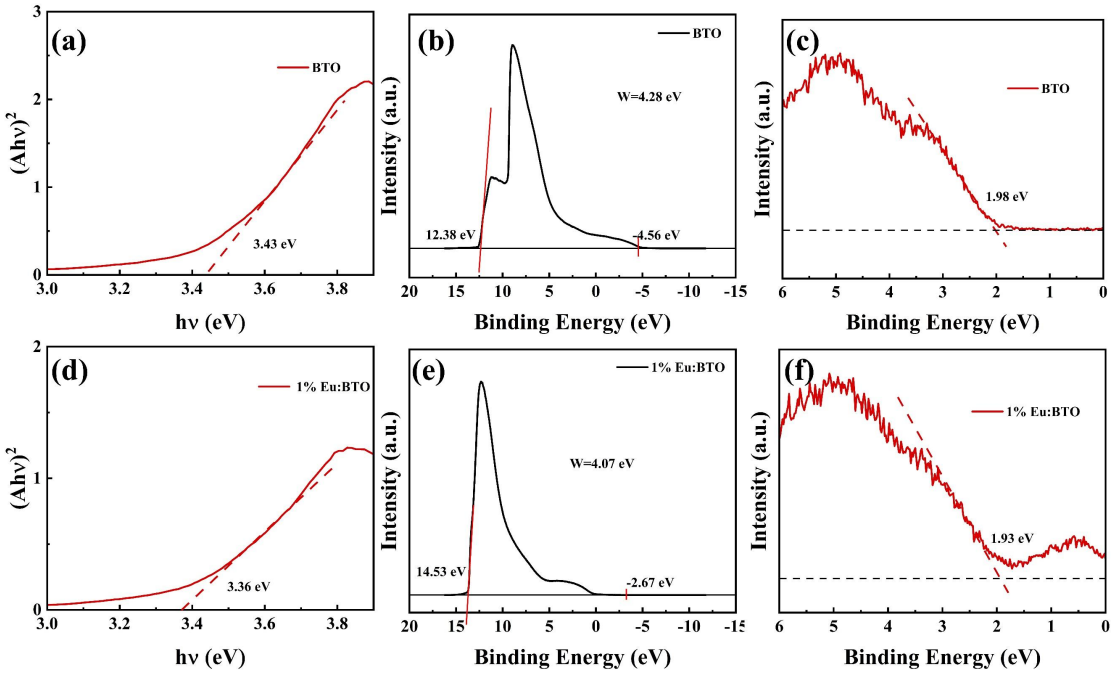

Fig. S5 Tauc diagram of (a)BTO and (d) 1%Eu:BTO, UPS spectra of (b) BTO and (e) 1%Eu:BTO, and XPS valence band spectra of (c) BTO and (f) 1%Eu:BTO.

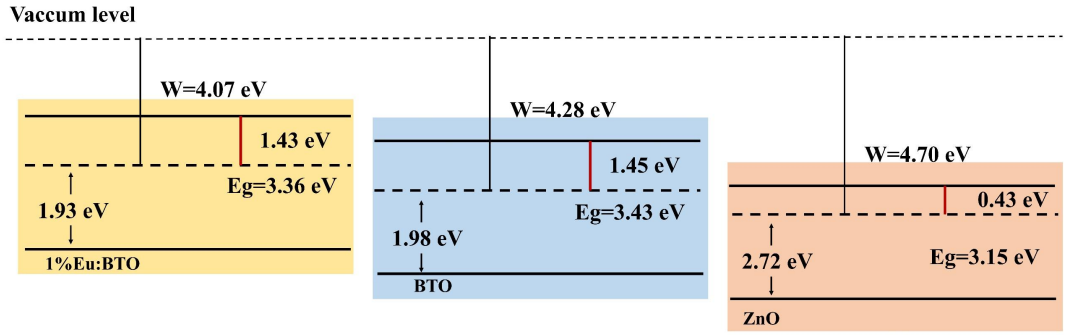

Fig. S6 Band structure diagrams of BTO and 1%Eu:BTO.

Table S1 Comparison Table of ZnO/BTO Structure Photodetectors with Other Reports

Device	**R (μA/W)**	**D* (Jones)**	**t_r (s)**	**t_d (s)**	**Ref.**
ZnO/Eu:BTO Photoconductive	298.00	$1430*10^{10}$	0.51	1.04	This work
Zno/ BTO Photoconductive	154.25	$298*10^{10}$	1.73	5.64	[1]
ZnO/BTO	-	-	<0.50	<0.50	[2]
ZnO-NFA/BTO	1410.00	1.48×10^{9}	0.12	0.74	[3]

[1] P. Hong., X. Cui., N. Li., et al. Performance enhancement of photoconductive detector based on ZnO film via the synergistic effect of heterojunction and polarization electric field[J], Physica B: Condensed Matter, (2026), 726: 418264.
[2] Y. Zhang., X. Zhao., J. Chen., et al. Self-Polarized BaTiO3 for Greatly Enhanced Performance of ZnO UV Photodetector by Regulating the Distribution of Electron Concentration[J], Advanced Functional Materials, (2019), 30: 1907650.
[3] P. Yu., W. Wang., T. Zheng., et al. Pyro-Phototronic Effect-Enhanced Photocurrent of a Self-Powered Photodetector Based on ZnO Nanofiber Arrays/$BaTiO_3$ Films[J], ACS Applied Materials & Interfaces, (2023), 15: 46031-46040.