Supporting Information

Promoting photocatalytic hydrogen evolution over perovskite oxide of $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$ by plasmon-induced hot electron injection

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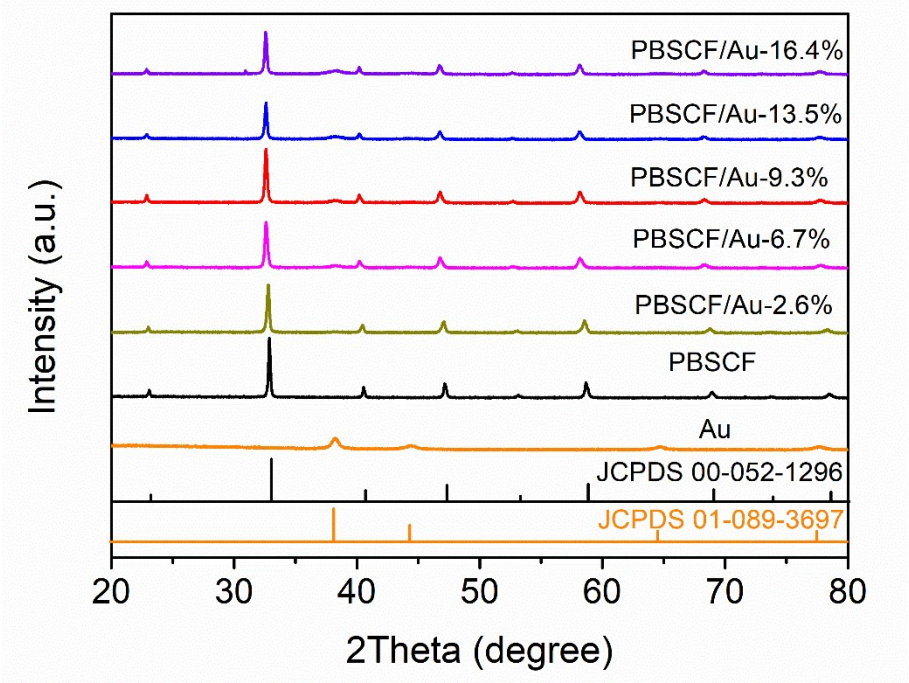
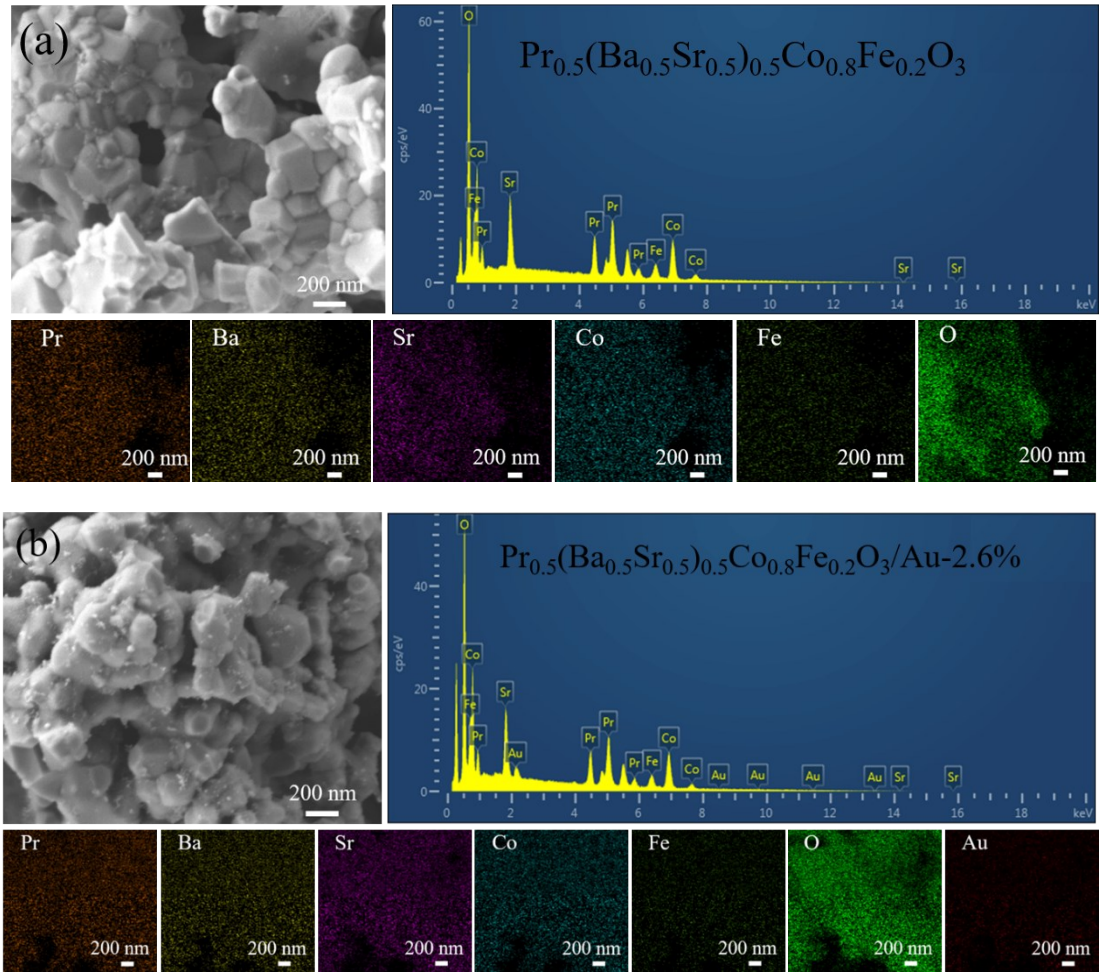
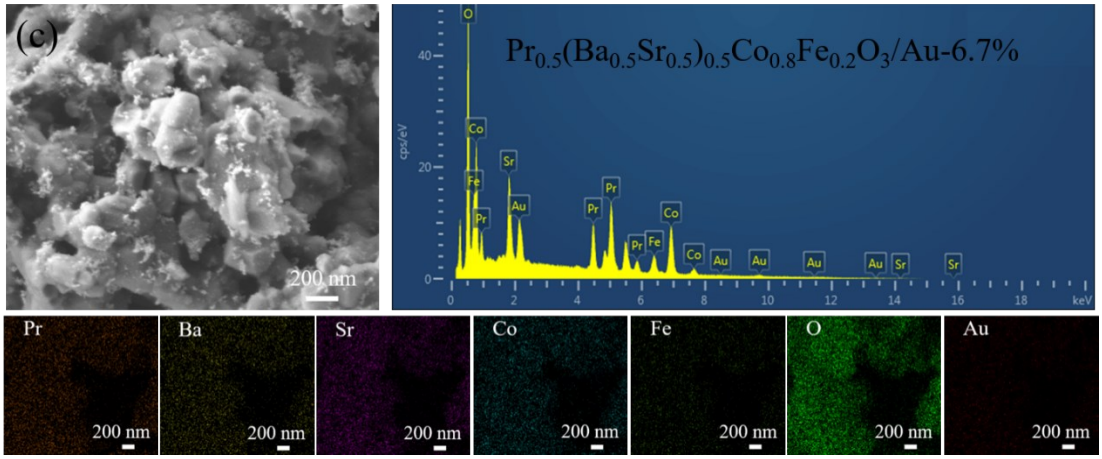
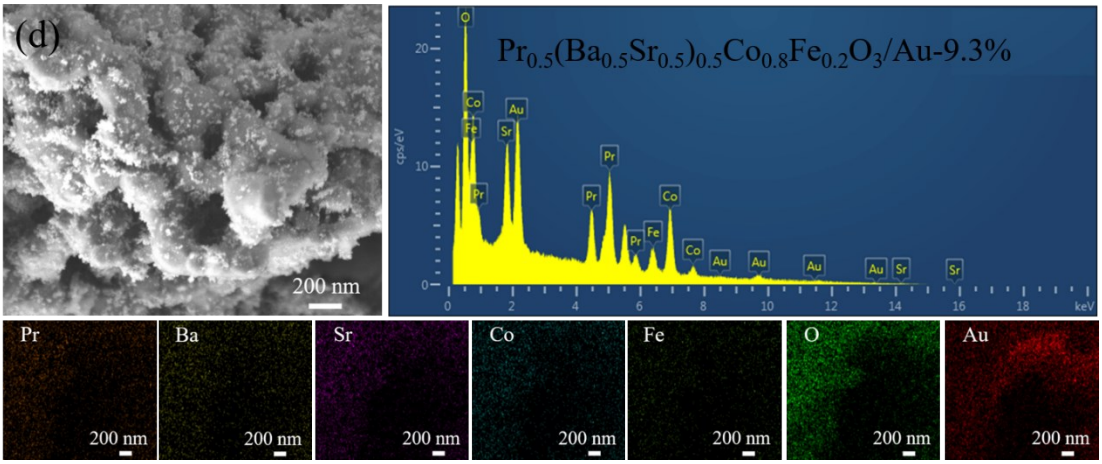
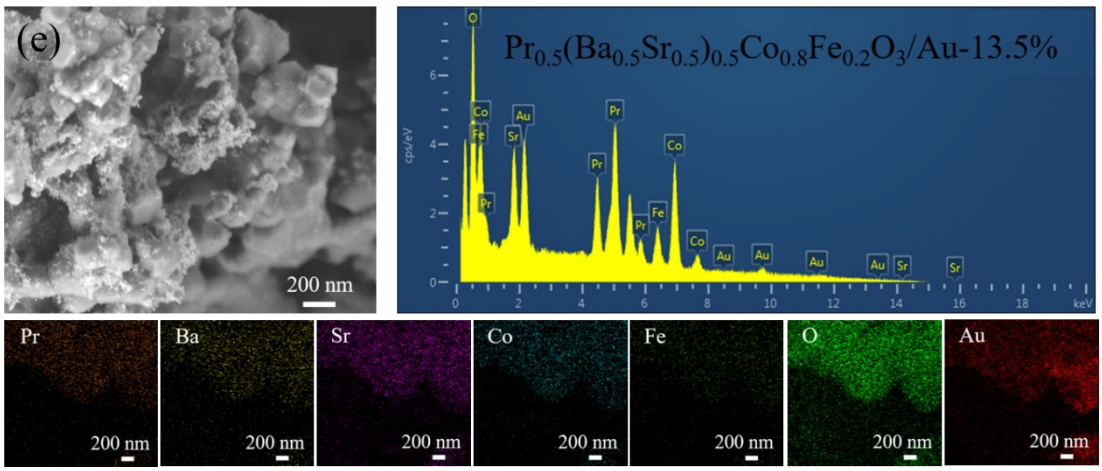


Fig. S1 XRD patterns of the as-prepared PBSCF/Au composites with different amount of Au loading.




(c)
200 nm
$Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-6.7%
cps/eV
keV
Pr
Ba
Sr
Co
Fe
O
Au
200 nm


(d)
200 nm
$Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-9.3%
cps/eV
keV
Pr
Ba
Sr
Co
Fe
O
Au
200 nm


(e)
200 nm
$Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-13.5%
cps/eV
keV
Pr
Ba
Sr
Co
Fe
O
Au
200 nm

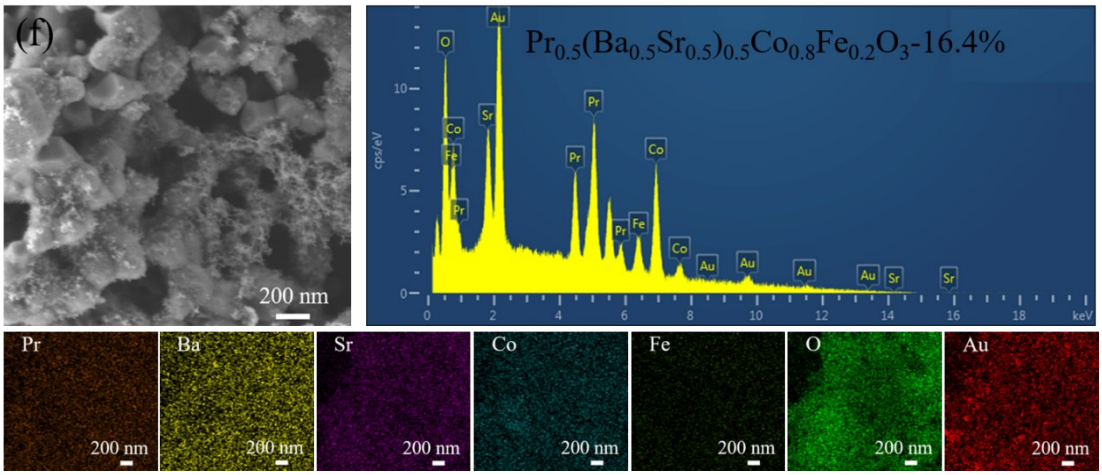


Fig. S2 SEM, EDS and corresponding elemental mapping images of (a) $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$, (b) $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-2.6%, (c) $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-6.7%, (d) $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-9.3%, (e) $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-13.5%, (f) $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-16.4%.

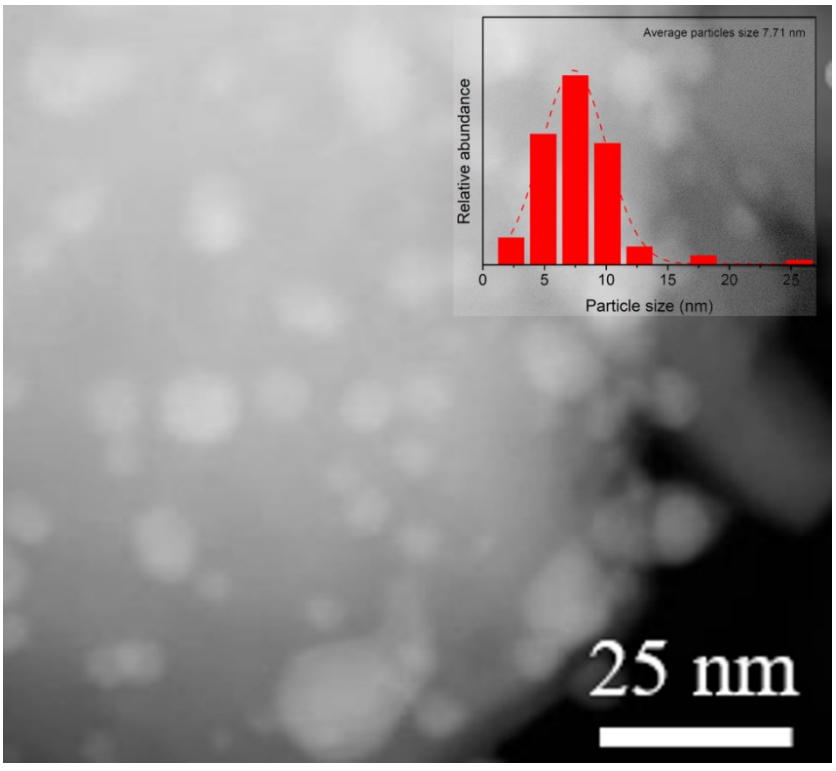


Fig. S3 The size distribution of Au nanoparticles on XXX.

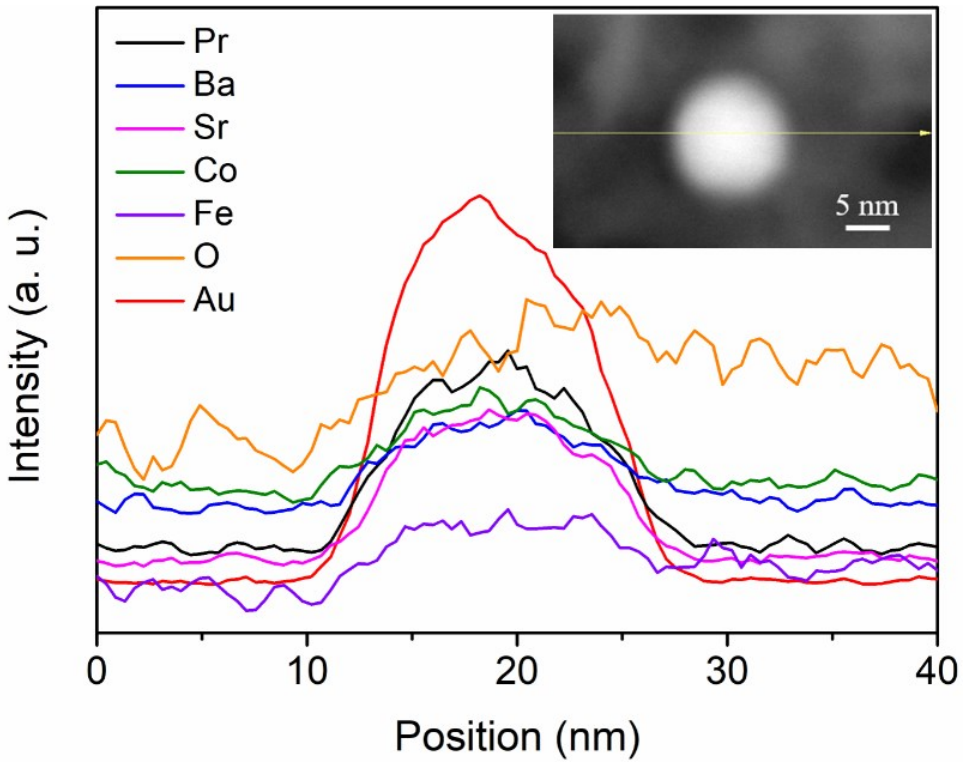


Fig. S4 The linear scan of PBSCF/Au-9.3%.

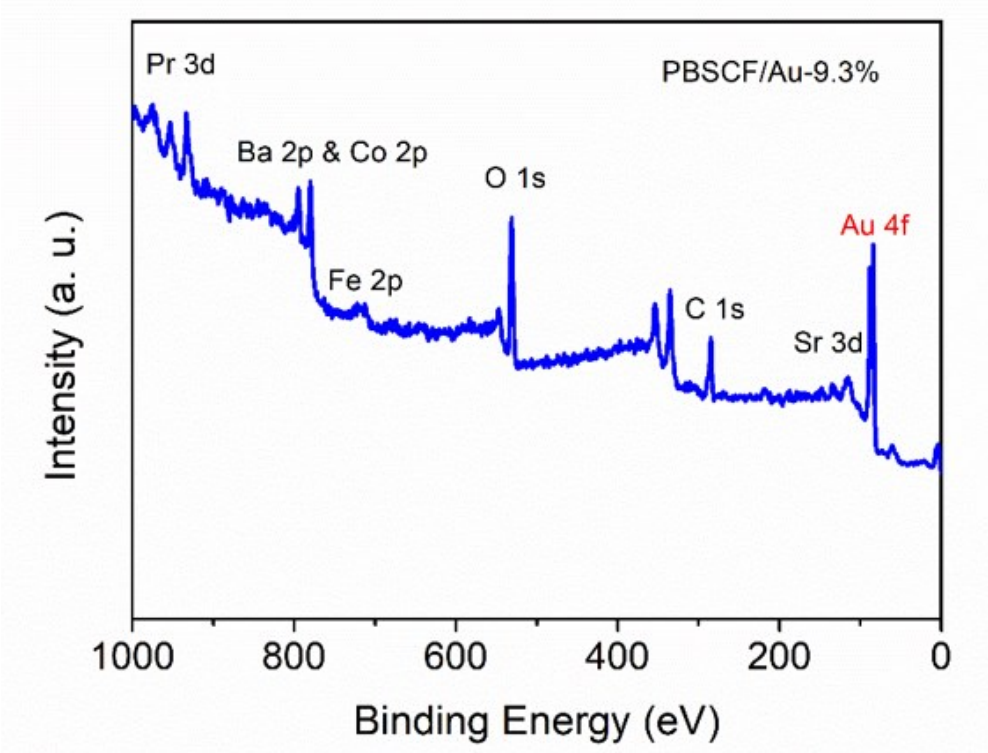


Fig. S5 XPS survey spectra of $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-9.3%.

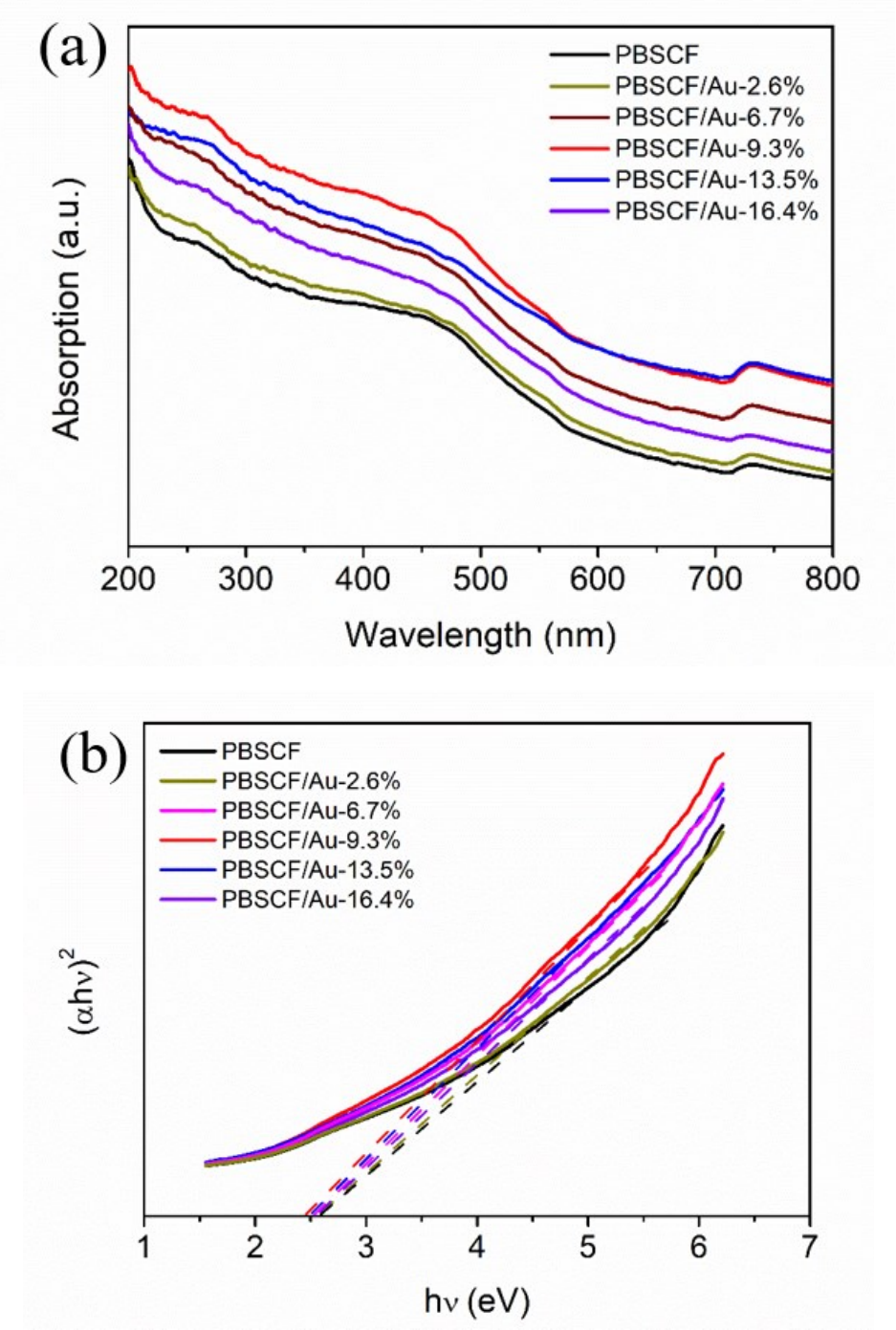


Fig. S6 (a) Absorption spectra of the as-prepared PBSCF/Au composites with different loading amount of Au. (b) Corresponding optical band gaps of PBSCF/Au composites determined by Tuac's equation.

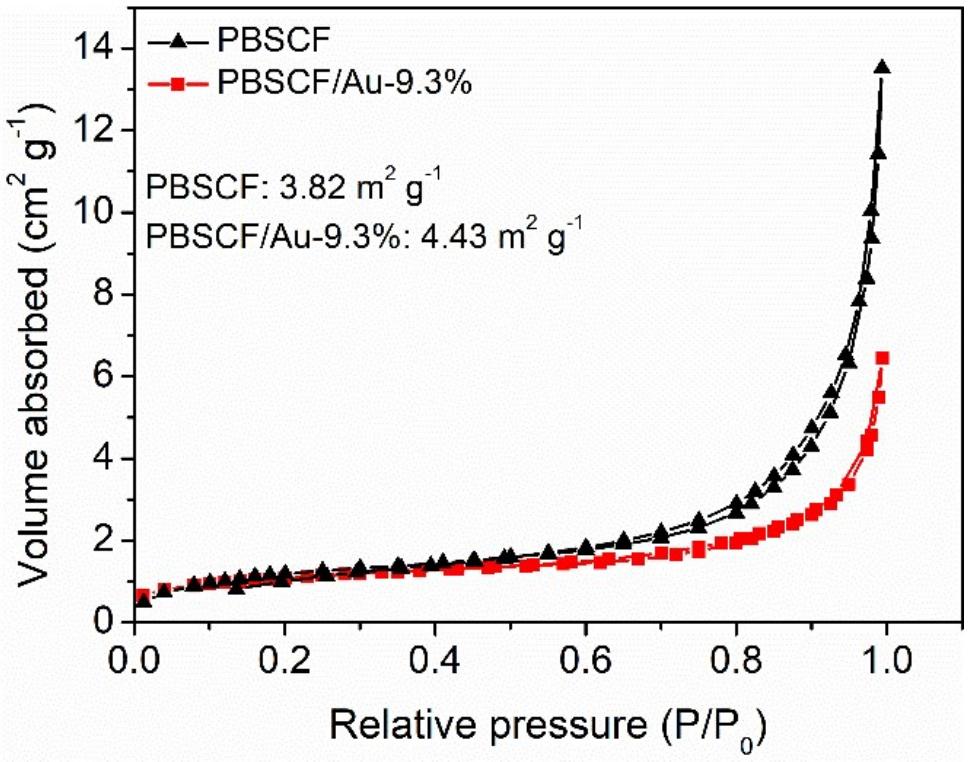


Fig. S7 The BET of PBSCF and PBSCF/Au-9.3%.

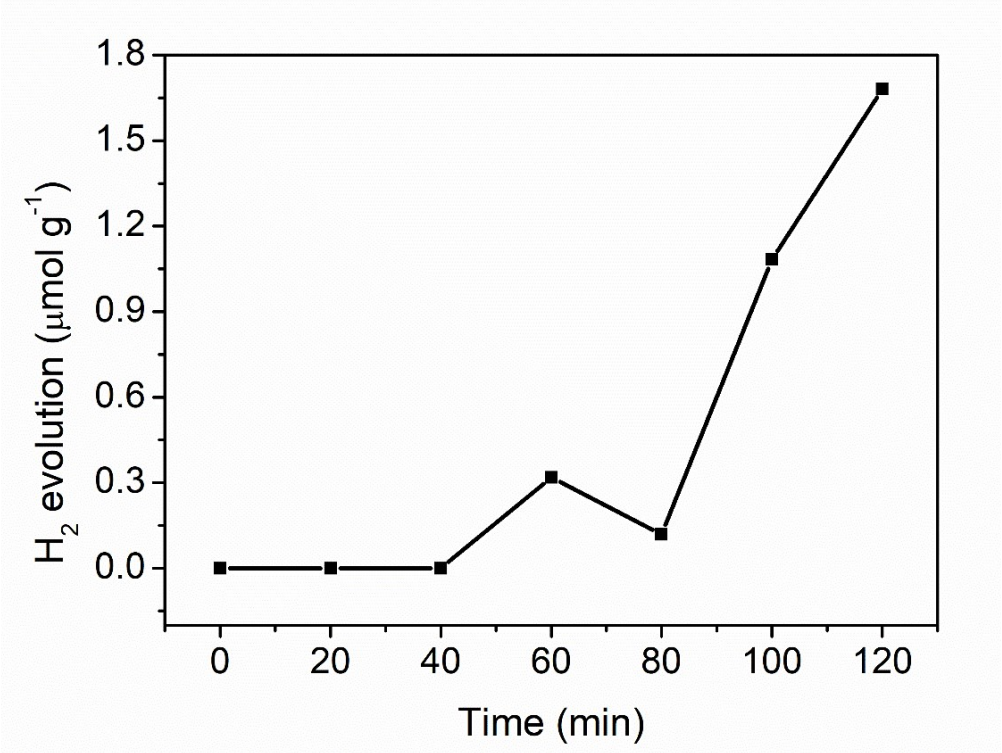


Fig. S8 Photocatalytic hydrogen evolution rates of bare Formaldehyde aqueous solution.

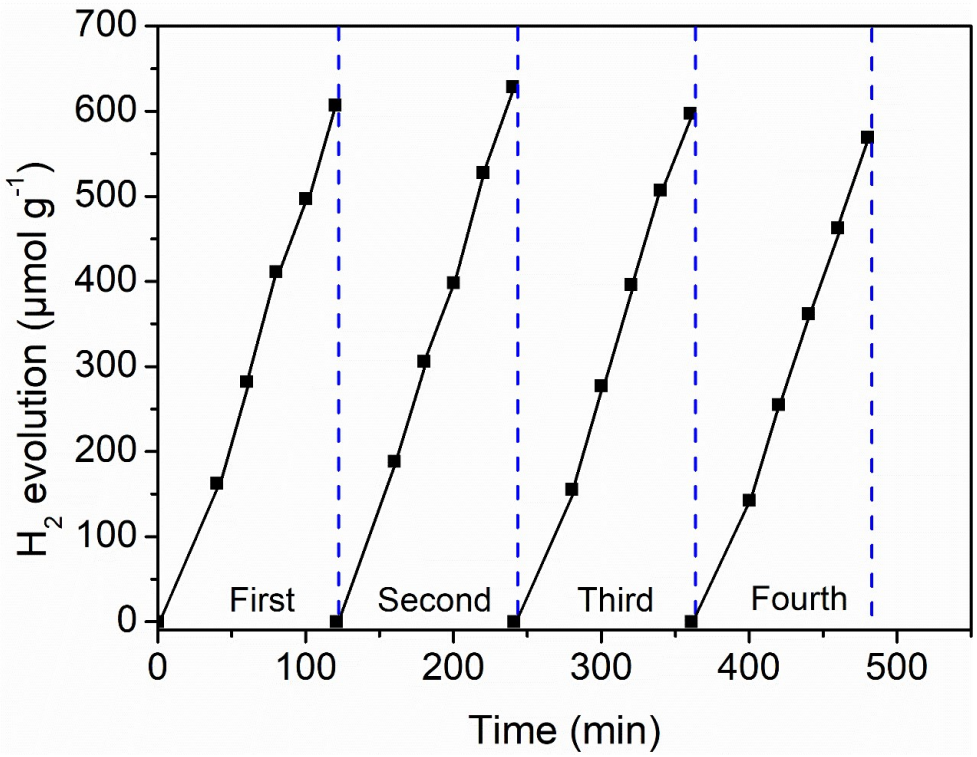


Fig. S9 Cycling performance of $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-9.3% under the illumination of visible light (λ>420 nm).

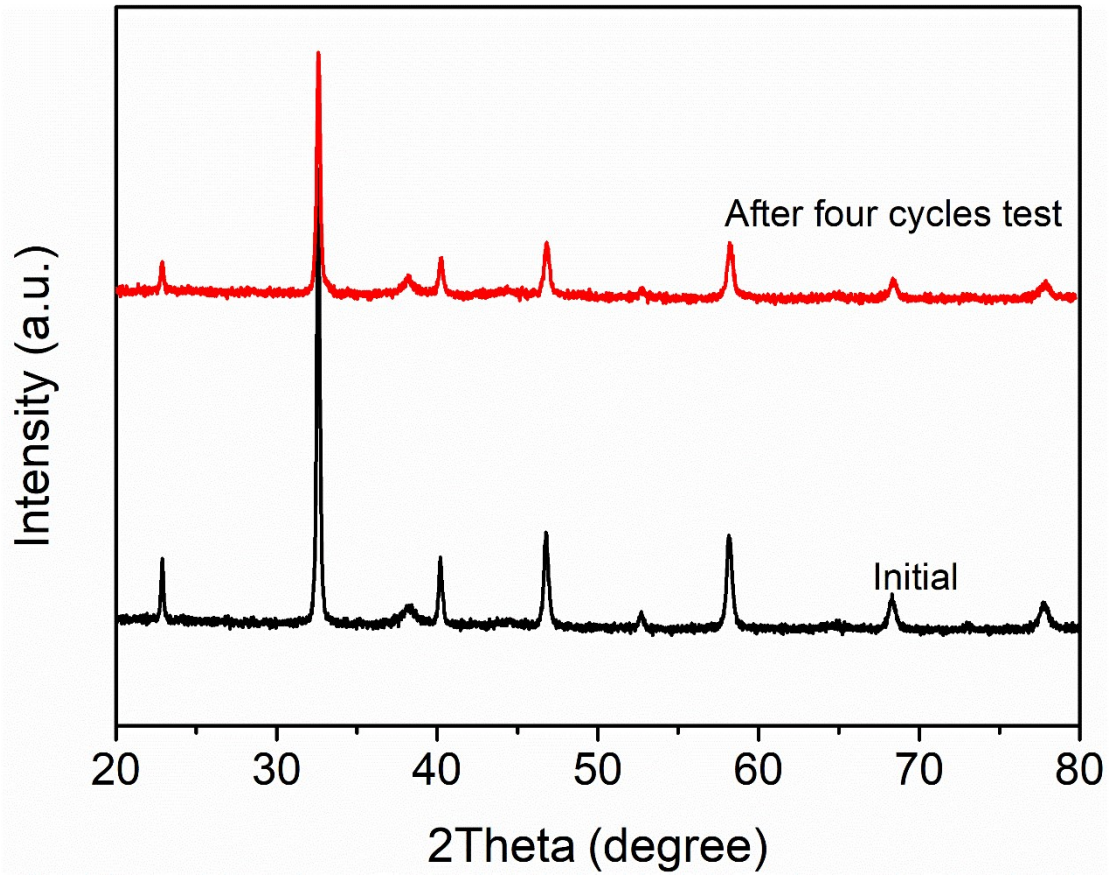


Fig. S10 XRD patterns of $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-9.3% and the one that

after stability test.

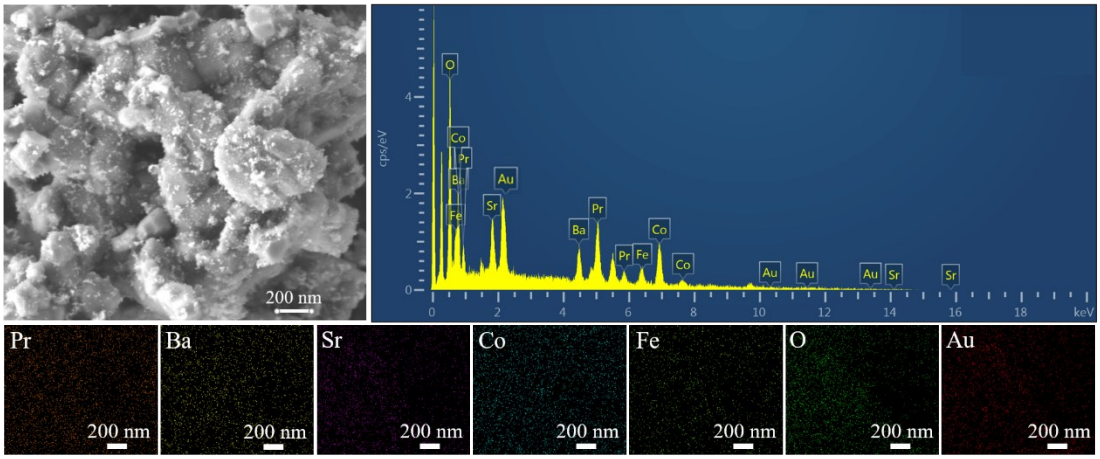


Fig. S11 SEM, EDS and corresponding elemental mapping images of $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$/Au-9.3% that after stability test.

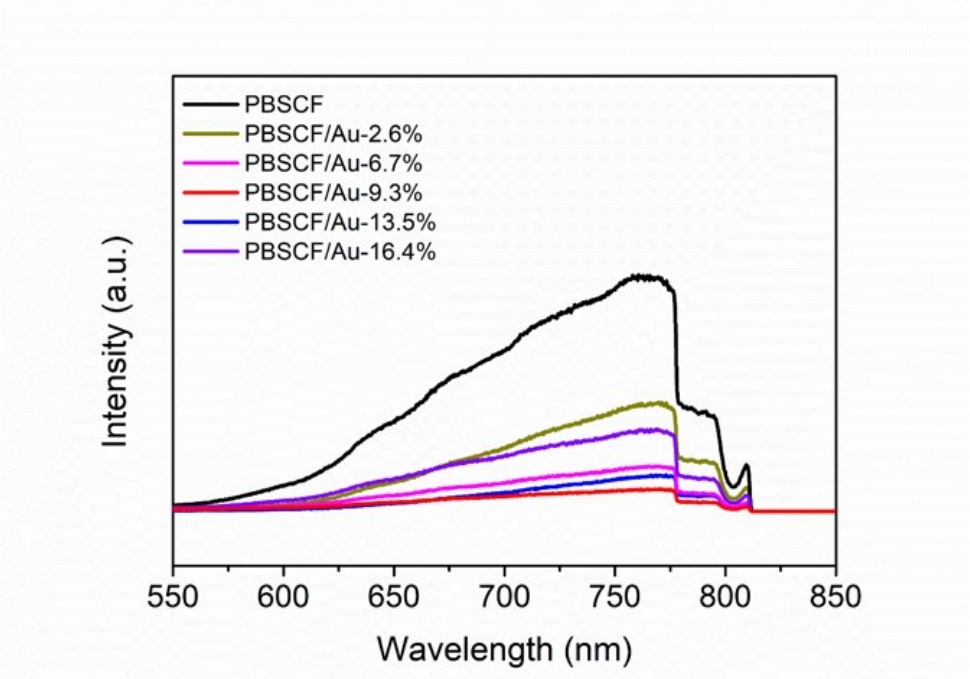


Fig. S12 Photoluminescence spectra of the as-prepared PBSCF/Au composites with different amount of Au loading.

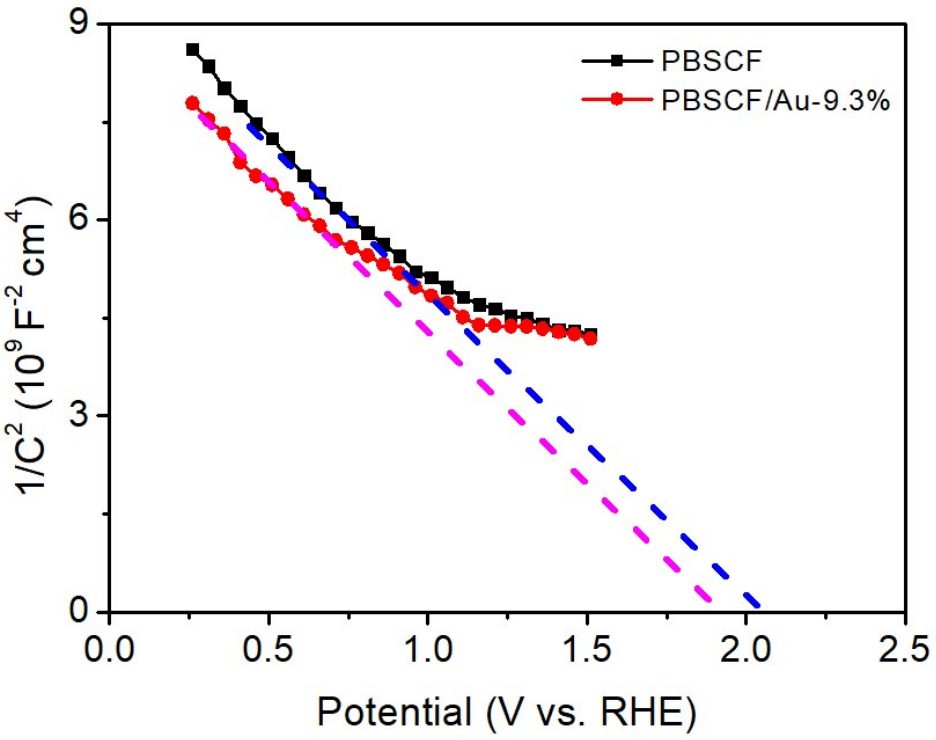
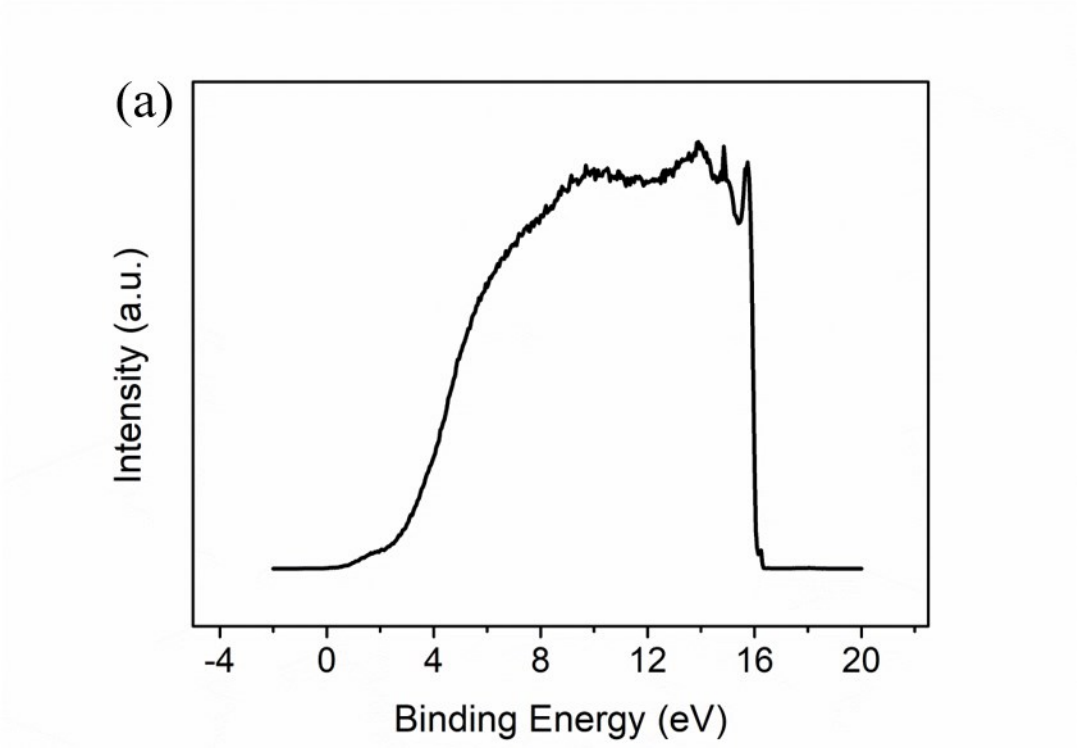


Fig. S13 Mott-Schottky characteristic of bare PBSCF and PBSCF/Au-9.3%.



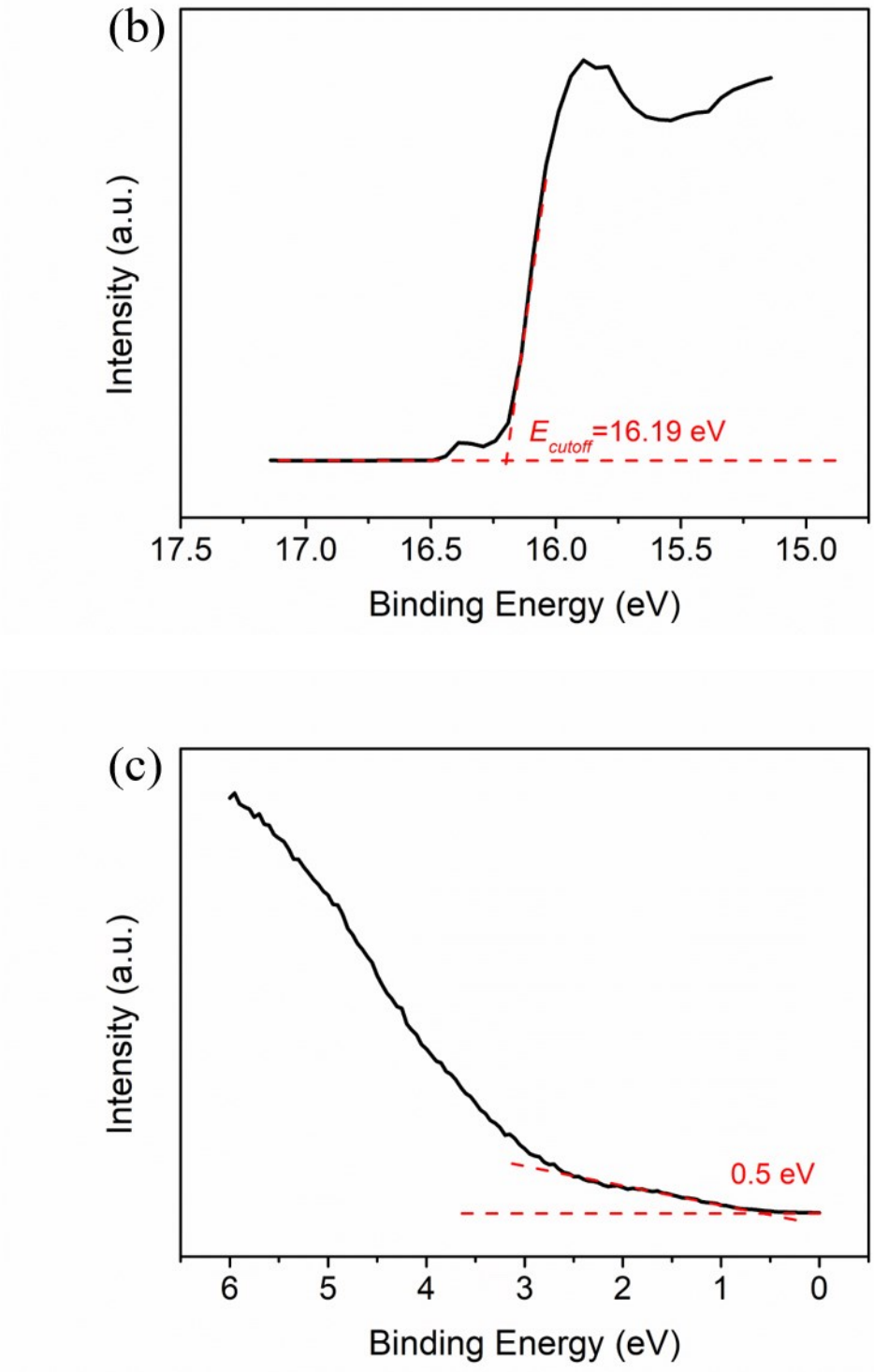


Fig. S14 (a) UPS spectrum of bare $Pr_{0.5}(Ba_{0.5}Sr_{0.5})_{0.5}Co_{0.8}Fe_{0.2}O_3$, (b) the corresponding electron cutoff energies and (c) the valence band position determined from UPS spectrum.

Table S1. Comparison of hydrogen evolution efficiency of our as-prepared catalyst with the reported ones

Catalysts	Yield of H_2 (μ mol g^{-1} h^{-1})	References
PBSCF/Au-9.3%	**1618.0**	**This work**
$LaCoO_3$-0.5% Au	42.0	1
$Ca_{0.8}La0_{.2}Ti_{0.8}Cr_{0.2}O_3$+1 wt% Pt	495.1	2
$SrTiO_3$:Rh(1%)+Pt(0.1 wt %)	300.0	3
$CaTi_{0.99}Cu_{0.01}O_3$	784.2	4
$CaTi_{0.98}Cu_{0.02}O_3$	1447.8	4
$CaTi_{0.97}Cu_{0.03}O_3$	358.6	4
$LaNi_{0.7}Cu_{0.3}O_3$	582.0	5
$SrTiO_3/Fe_2O_3$	85.0	6
$SrTiO_3/BiFeO_3$	129.0	6
$LaNiO_3$/CdS	3700.0	7

1. B.-T. Zhang, J. Liu, S. Yue, Y. Teng, Z. Wang, X. Li, S. Qu and Z. Wang, *Appl. Catal., B*, 2017, **219**, 432-438.
2. R. Wang, S. Ni, G. Liu and X. Xu, *Appl. Catal., B*, 2018, **225**, 139-147.
3. R. Konta, T. Ishii, H. Kato and A. Kudo, *J. Phys. Chem. B*, 2004, **108**, 8992-8995.
4. H. Zhang, G. Chen, Y. Li and Y. Teng, *Int. J. Hydrogen Energy*, 2010, **35**, 2713-2716.
5. J. Li, L. Jia, W. Fang and J. Zeng, *Int. J. Hydrogen Energy*, 2010, **35**, 5270-5275.
6. J. Luo and P. A. Maggard, *Adv. Mater.*, 2006, **18**, 514-517.
7. J. Xu, C. Sun, Z. Wang, Y. Hou, Z. Ding and S. Wang, *Chem.–Eur. J.*, 2018, **24**, 18512-18517.