Electronic Supplementary Information

Ternary Pt/SnO_x/TiO_2 photocatalysts for hydrogen production: Consequence of Pt sites for synergy of dual co-catalysts

Quan Gu, Jinlin Long*, Huaqiang Zhuang, Chaoqiang Zhang, Yangen Zhou, and Xuxu Wang *

Research Institute of Photocatalysis, Fujian Provincial Key Laboratory of Photocatalysis--State Key Laboratory Breeding Base, Fuzhou University, Fuzhou 350002, China

E-mail: jllong@fzu.edu.cn ; xwang@fzu.edu.cn

Personal URL: http://chem.fzu.edu.cn/szdw/teacherinfo.aspx?id=40

Tel: +86-591-83779121; fax: +86-591-83779121

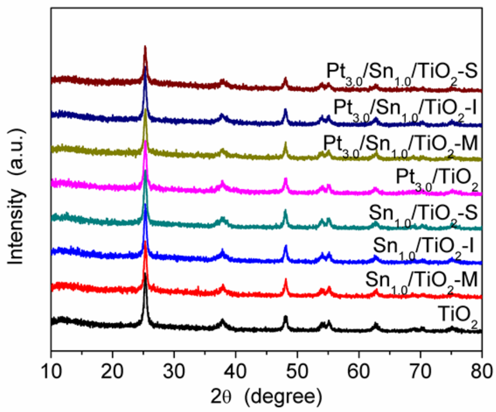


Fig. S1 The XRD patterns of TiO_2, $Pt_{3.0}/TiO_2$, $Sn_{1.0}/TiO_2$ samples prepared by different methods, and $Pt_{3.0}/Sn_{1.0}$-TiO_2 samples prepared by different methods.

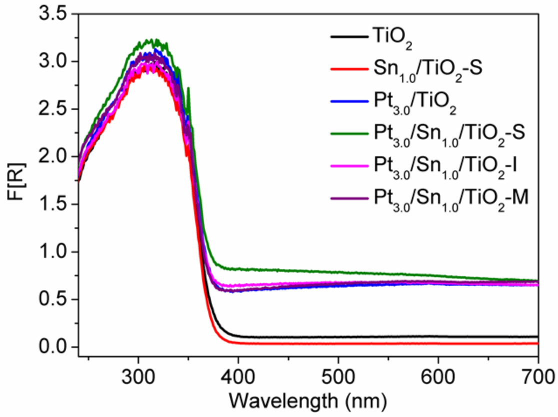


Fig. S2 UV–vis diffuse reflectance spectra of samples

Figure S2 shows UV-Vis DRS spectra of $Sn_{1.0}/TiO_2$-S, $Pt_{3.0}/TiO_2$, $Pt_{3.0}/Sn_{1.0}/TiO_2$-S, $Pt_{3.0}/Sn_{1.0}/TiO_2$-I and $Pt_{3.0}/Sn_{1.0}/TiO_2$-M samples. Clearly, UV-Vis DRS spectrum of $Sn_{1.0}/TiO_2$-S is coincide with that of TiO_2, indicating that Sn modification results in no alterations in the optical absorption properties of TiO_2. The spectra of the all Pt loaded samples ($Pt_{3.0}/TiO_2$, $Pt_{3.0}/Sn_{1.0}/TiO_2$-S, $Pt_{3.0}/Sn_{1.0}/TiO_2$-I and $Pt_{3.0}/Sn_{1.0}/TiO_2$-M) show an enhanced absorption in the visible-light region but the shape and optical absorption threshold of the spectra is similar with that of parent TiO_2. According to the reference (J. Yu, L. Qi, M. Jaroniec, *J. Phys. Chem. C* 2010, **114**, 13118.), absorption in visible light region is due to the fact that highly dispersed platinum nanoparticles can absorb nearly all the incident light. Therefore, this result can further confirms that the Pt nanoparticles are highly dispersed onto surface of samples and closely contacted with TiO_2.

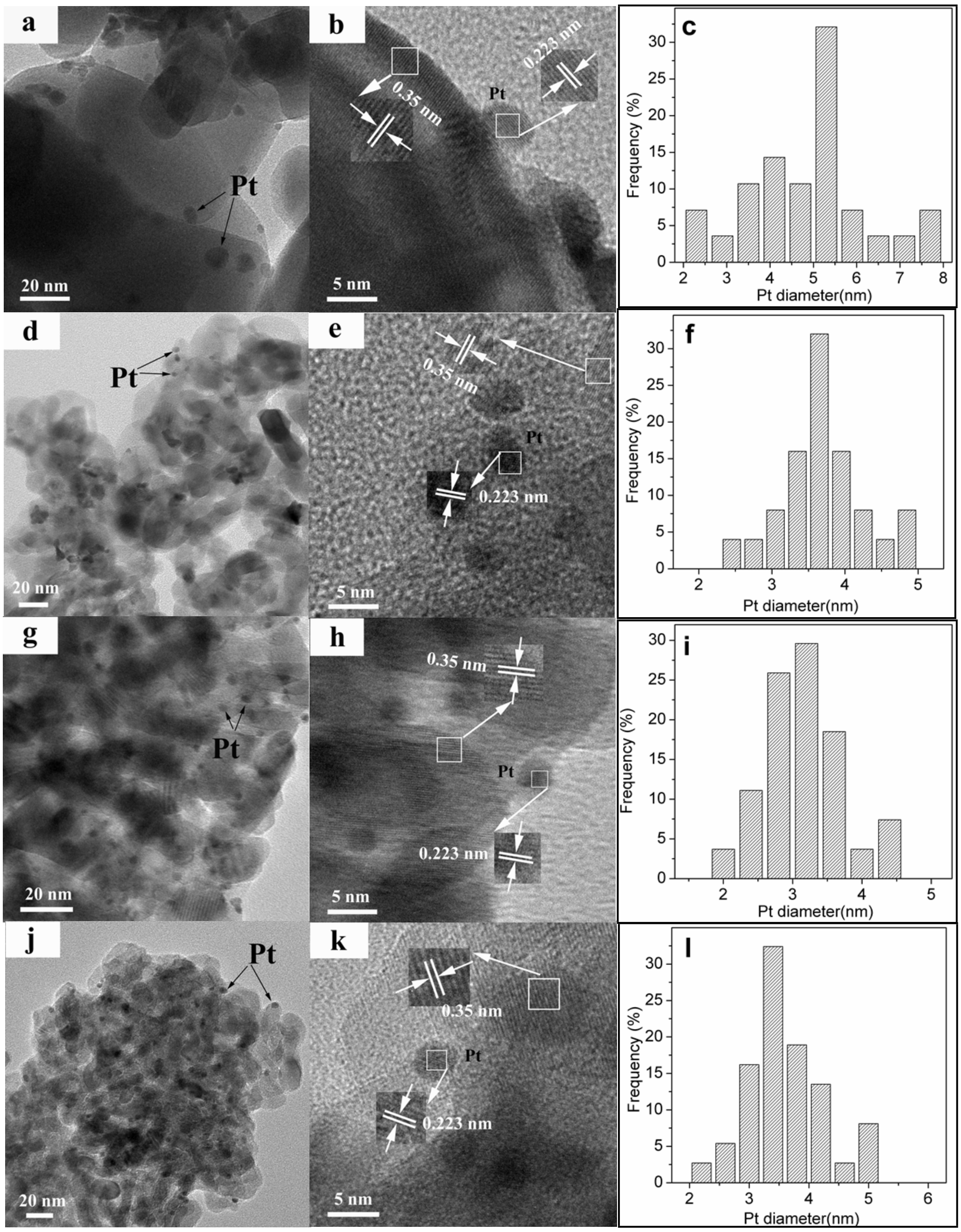


Fig. S3 TEM and HRTEM images of $Pt_{3.0}/SnO_2$ (a and b), $Sn_{1.0}/Pt_{3.0}/TiO_2$-M (d and e), $Sn_{1.0}/Pt_{3.0}/TiO_2$-I(g and h), and $Sn_{1.0}/Pt_{3.0}/TiO_2$-S (j and k) samples. The statistical size distributions of Pt particles on $Pt_{3.0}/SnO_2$ (c), $Sn_{1.0}/Pt_{3.0}/TiO_2$-M (f), $Sn_{1.0}/Pt_{3.0}/TiO_2$-I (i), and $Sn_{1.0}/Pt_{3.0}/TiO_2$-S (l).

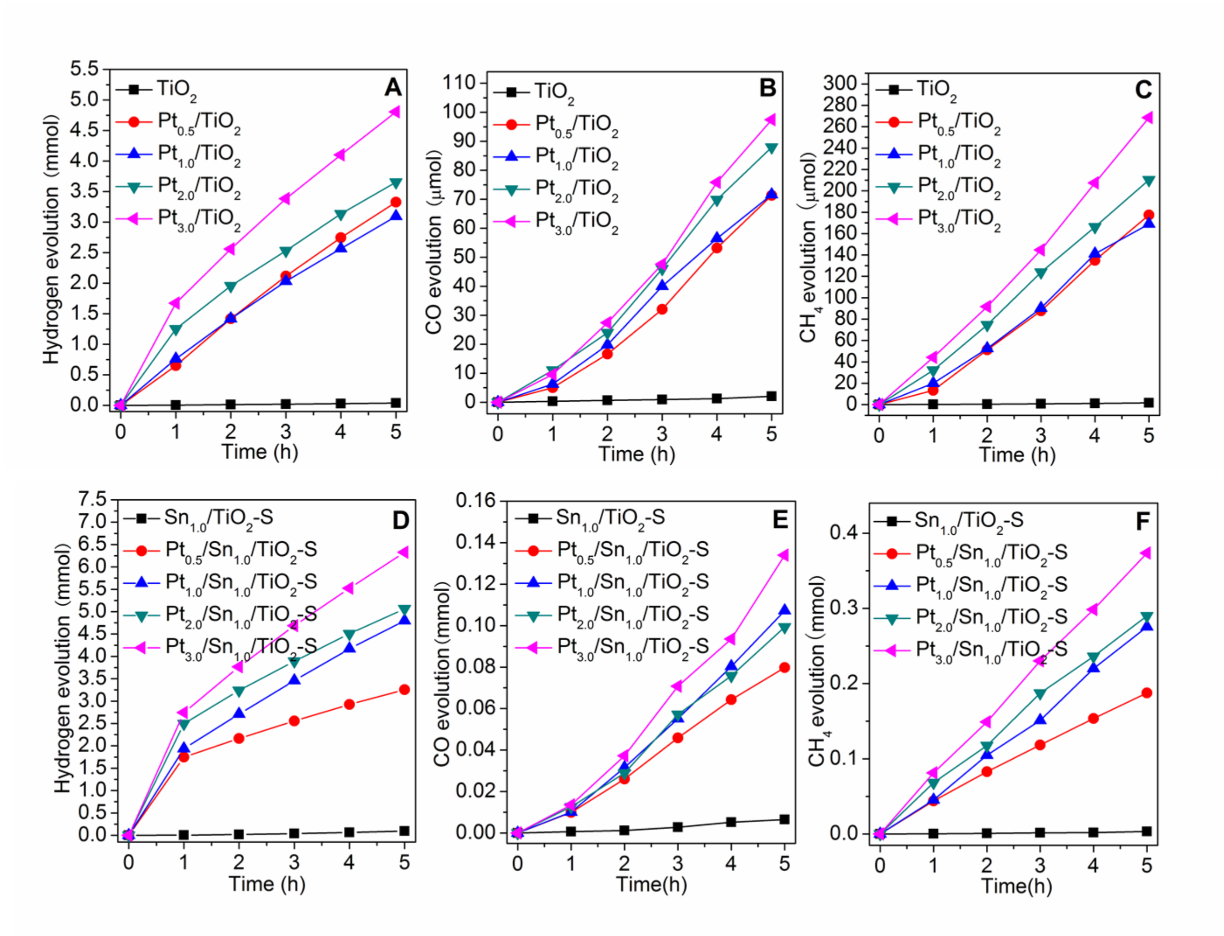


Fig. S4 The generation of H_2 (A and D), CO (B and E), and CH_4 (C and F) from the ethanol solution over the Pt_x/TiO_2 and $Pt_x/Sn_{1.0}/TiO_2$-S with different Pt contents, respectively.

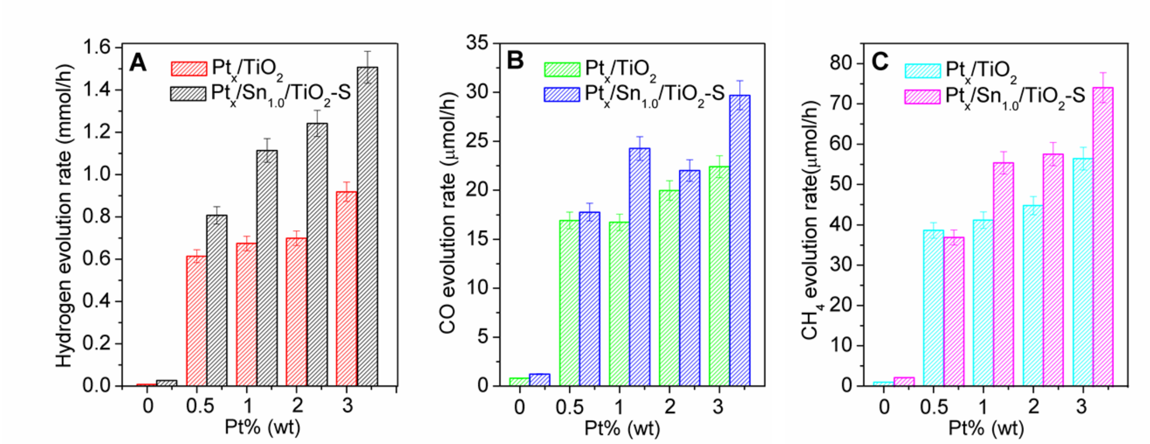


Fig. S5. The production rates of H_2 (A), CO (B), and CH_4 (C) from ethanol solution over the Pt_x/TiO_2 and $Pt_x/Sn_{1.0}/TiO_2$-S with different Pt contents

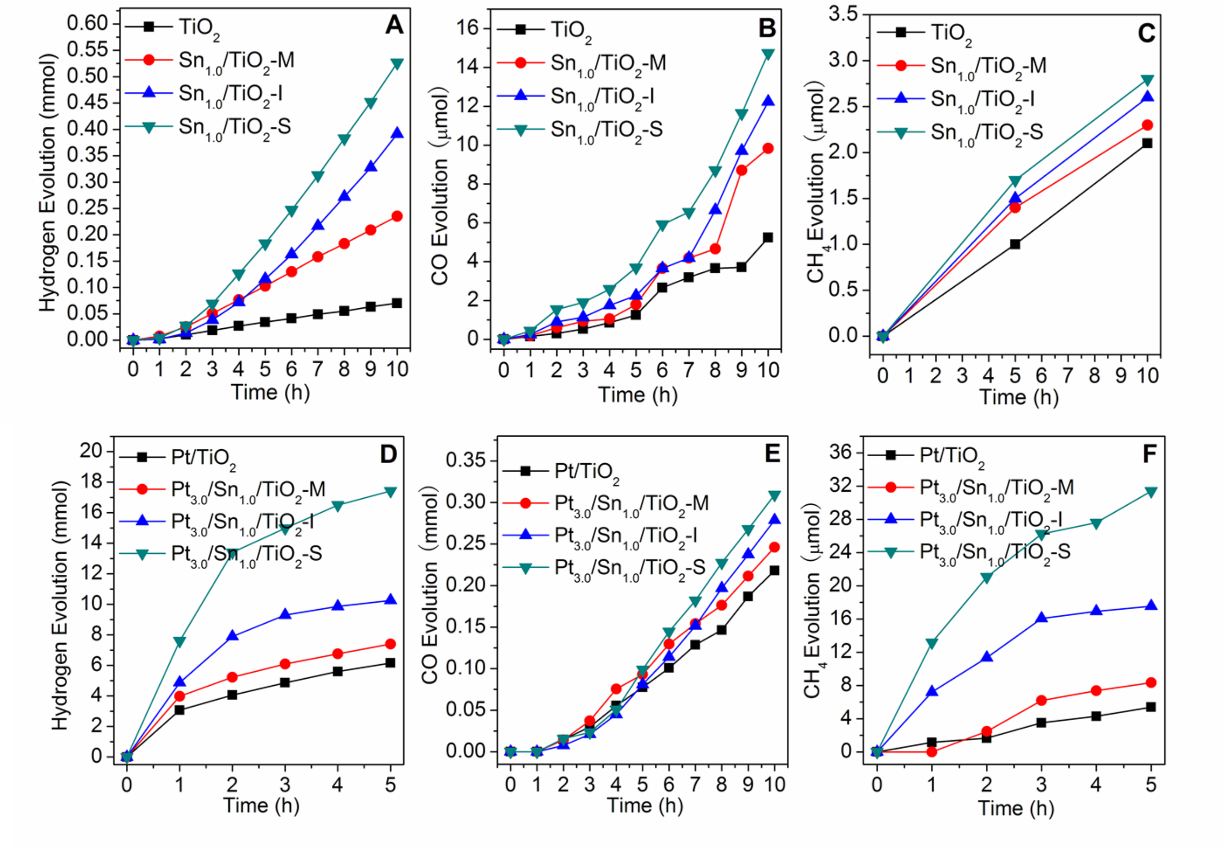


Fig. S6 The generation of H_2 (A and D), CO (B and E), and CH_4 (C and F) from the methanol solution over the $Sn_{1.0}/TiO_2$ and $Pt_{3.0}/Sn_{1.0}/TiO_2$ prepared by different methods, respectively

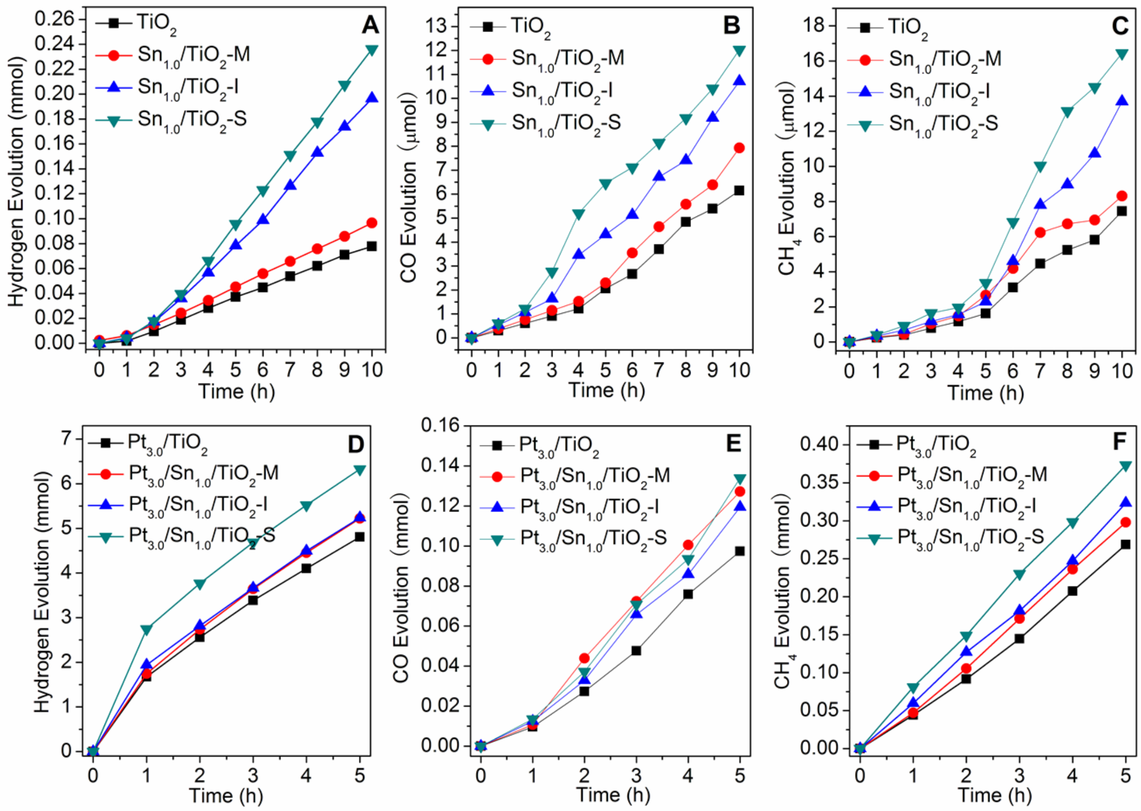
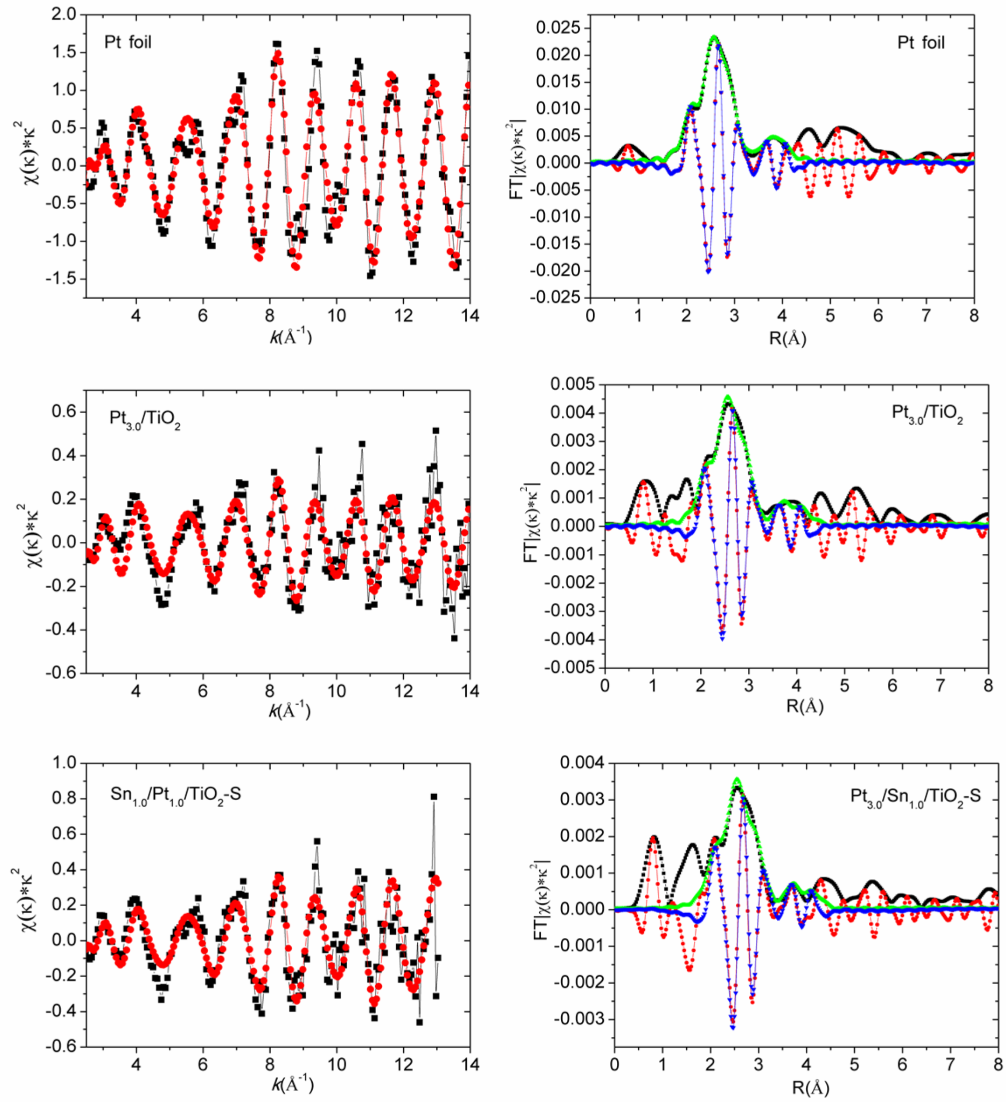
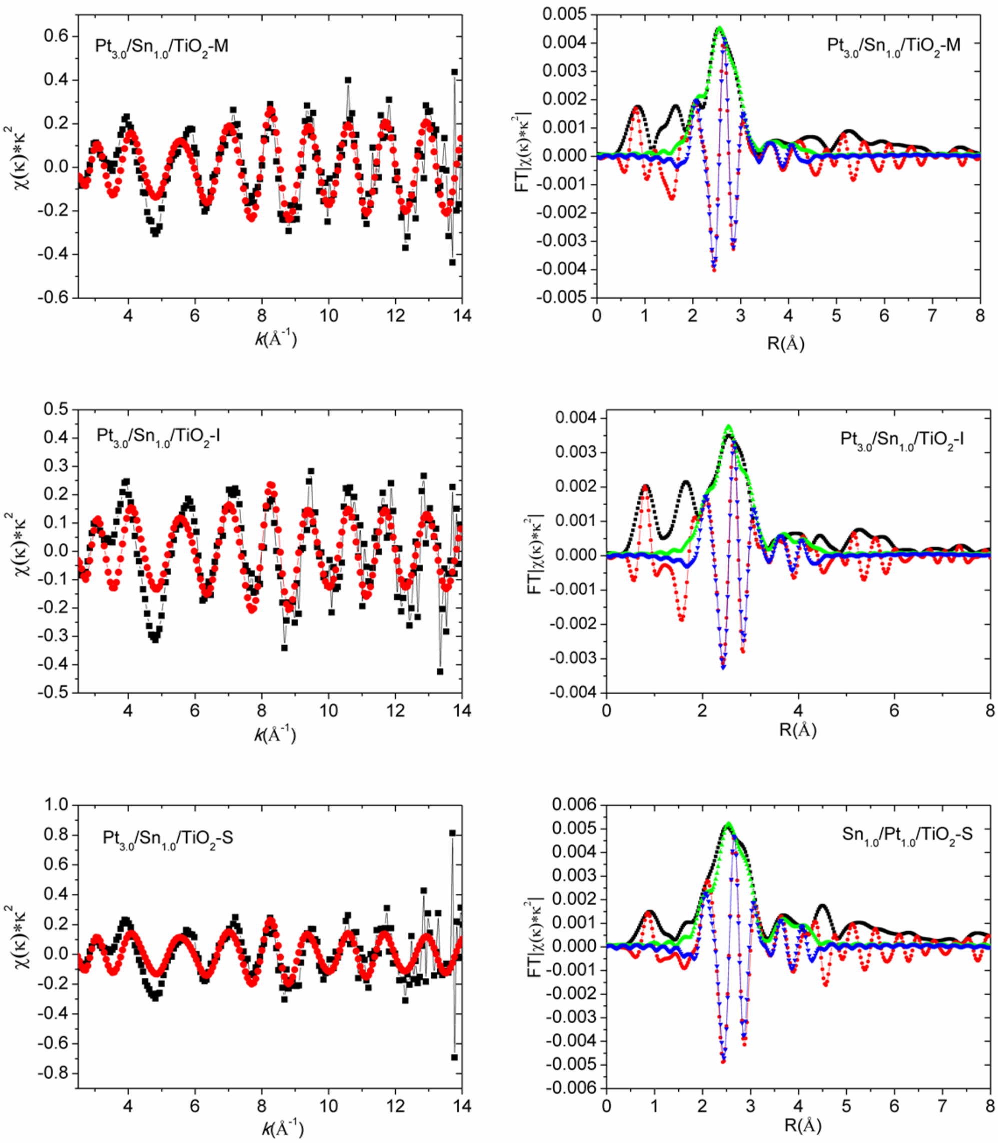
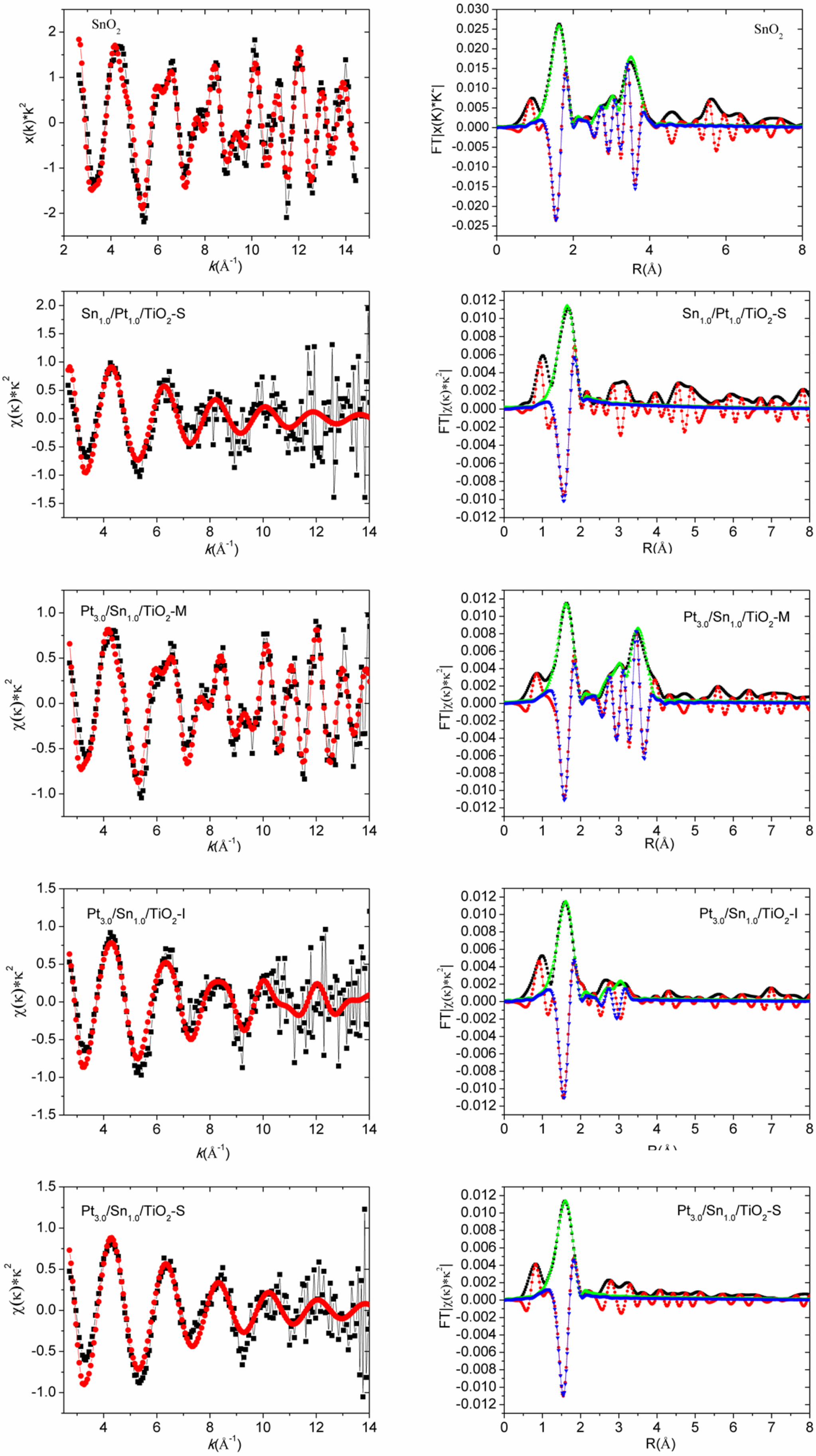


Fig. S7 The generation of H_2 (A and D), CO (B and E), and CH_4 (C and F) from the ethanol solution over the $Sn_{1.0}/TiO_2$ and $Pt_{3.0}/Sn_{1.0}/TiO_2$ prepared by different methods, respectively



Pt foil
Pt foil
Pt$_{3.0}$/TiO$_2$
Pt$_{3.0}$/TiO$_2$
Sn$_{1.0}$/Pt$_{1.0}$/TiO$_2$-S
Pt$_{3.0}$/Sn$_{1.0}$/TiO$_2$-S
χ(κ)*κ^2
FT|χ(κ)*κ^2|
k(Å^{-1})
R(Å)


Pt3.0/Sn1.0/TiO2-M
Pt3.0/Sn1.0/TiO2-I
Pt3.0/Sn1.0/TiO2-S
Sn1.0/Pt1.0/TiO2-S
χ(κ)*κ2
k(Å-1)
FT|χ(κ)*κ2|
R(Å)



SnO_2
$\chi(k)*k^2$
$k(Å^{-1})$
SnO_2
$FT|\chi(K)*K^2|$
R(Å)
$Sn_{1.0}/Pt_{1.0}/TiO_2$-S
$\chi(\kappa)*\kappa^2$
$k(Å^{-1})$
$Sn_{1.0}/Pt_{1.0}/TiO_2$-S
$FT|\chi(\kappa)*\kappa^2|$
R(Å)
$Pt_{3.0}/Sn_{1.0}/TiO_2$-M
$\chi(\kappa)*\kappa^2$
$k(Å^{-1})$
$Pt_{3.0}/Sn_{1.0}/TiO_2$-M
$FT|\chi(\kappa)*\kappa^2|$
R(Å)
$Pt_{3.0}/Sn_{1.0}/TiO_2$-I
$\chi(\kappa)*\kappa^2$
$k(Å^{-1})$
$Pt_{3.0}/Sn_{1.0}/TiO_2$-I
$FT|\chi(\kappa)*\kappa^2|$
$Pt_{3.0}/Sn_{1.0}/TiO_2$-S
$\chi(\kappa)*\kappa^2$
$k(Å^{-1})$
$Pt_{3.0}/Sn_{1.0}/TiO_2$-S
$FT|\chi(\kappa)*\kappa^2|$
R(Å)

Fig. S8 Pt L_{III}-edge and Sn K-edge EXAFS fit results.

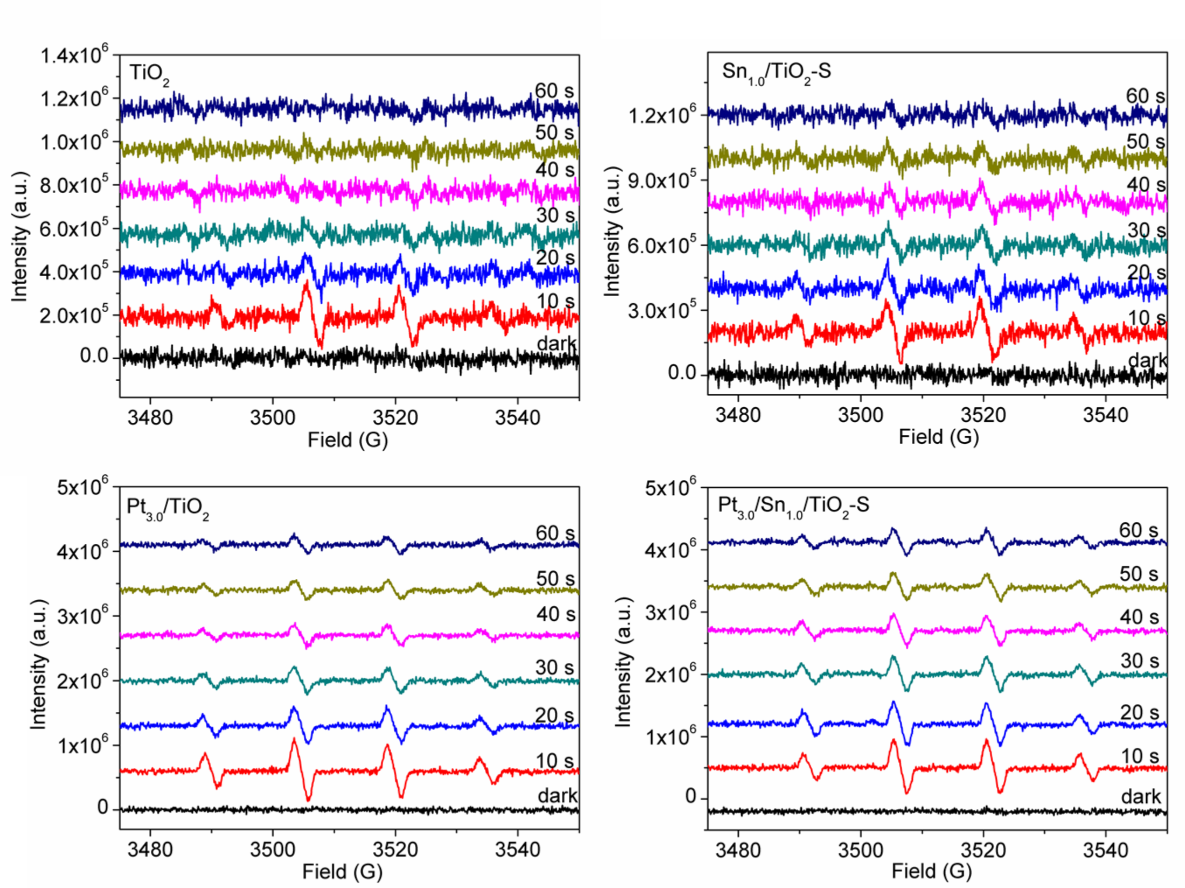


Fig. S9 The changes of EPR signal of the DMPO-•OH spin adducts in the suspension of TiO_2, $Sn_{1.0}/TiO_2$-S, $Pt_{3.0}/TiO_2$, and $Pt_{3.0}/Sn_{1.0}/TiO_2$-S with 365 nm light irradiation time, respectively.

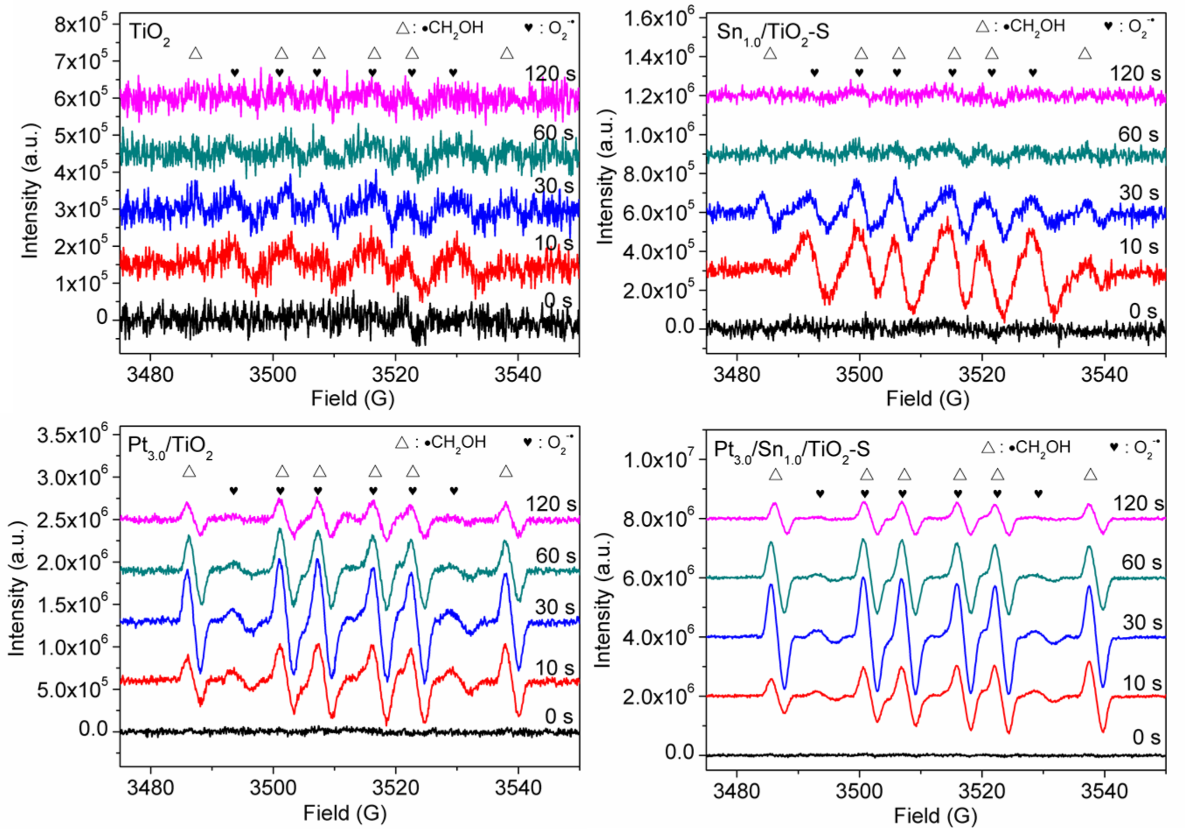


Fig. S10 EPR spectra of TiO_2, $Sn_{1.0}/TiO_2$-S, $Pt_{3.0}/TiO_2$, and $Pt_{3.0}/Sn_{1.0}/TiO_2$-S dispersed in DMPO/methanol with 365 nm light irradiation.