Title: Three narrow band-gap semiconductors modified Z-scheme photocatalysts, Er^{3+}:$Y_3Al_5O_{12}$@$NiGa_2O_4$/(NiS, CoS_2 or MoS_2)/$Bi_2Sn_2O_7$, for enhanced solar-light photocatalytic conversions of nitrite and sulfite

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PII: S1226-086X(18)30253-3
DOI: https://doi.org/10.1016/j.jiec.2018.05.024
Reference: JIEC 4008

To appear in:

Received date: 21-2-2018
Revised date: 7-5-2018
Accepted date: 18-5-2018

Please cite this article as: Xue Ma, Chunquan Wang, Guowei Wang, Guanshu Li, Siyi Li, Jun Wang, Youtao Song, Three narrow band-gap semiconductors modified Z-scheme photocatalysts, Er3+:Y3Al5O12@NiGa2O4/(NiS, CoS2 or MoS2)/Bi2Sn2O7, for enhanced solar-light photocatalytic conversions of nitrite and sulfite, Journal of Industrial and Engineering Chemistry https://doi.org/10.1016/j.jiec.2018.05.024

Journal of Industrial and Engineering Chemistry 00 (2018) 000-000

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Xue Ma [a], Chunquan Wang [a], Guowei Wang [b], Guanshu Li [a], Siyi Li [b], Jun Wang [a,b,*], Youtao Song [a,**]

[a] *College of Environment, Liaoning University, Shenyang 110036, P.R. China*

[b] *College of Chemistry, Liaoning University, Shenyang 110036, P.R. China*

Received 00 February 2018; received in revised form 00 February 2018; accepted 00 February 2018
Available online 00 February 2018

* Corresponding author. Tel.: +86 24 62207861; Fax: +86 24 62202053.
E-mail address: wangjun888tg@126.com (J. Wang); wangjun891@sina.com (J. Wang); ysong_tg@126.com (Y. Song).

Graphical abstract

A narrow band-gap NiS semiconductor like "conductive ladder" is inserted between Er^{3+}:$Y_3Al_5O_{12}$@$NiGa_2O_4$ and $Bi_2Sn_2O_7$ to accelerate the electron transfer from conduction band of $Bi_2Sn_2O_7$ to valence band of $NiGa_2O_4$. Er^{3+}:$Y_3Al_5O_{12}$ as an up-conversion luminescence agent (from visible-light to ultraviolet-light) provides enough ultraviolet-light for satisfying the energy demand of wide band-gap $NiGa_2O_4$. The prepared Z-scheme

http://dx.doi.org/00.0000/j.jiec.2018.00.000