ICARST 2017
1st International Conference on Applications of Radiation Science and Technology

中国科学技术大学
University of Science and Technology of China

Co-reduction Synthesis of *r*-GO Sheet/Au Composites by γ-Radiation and their Catalytic Properties

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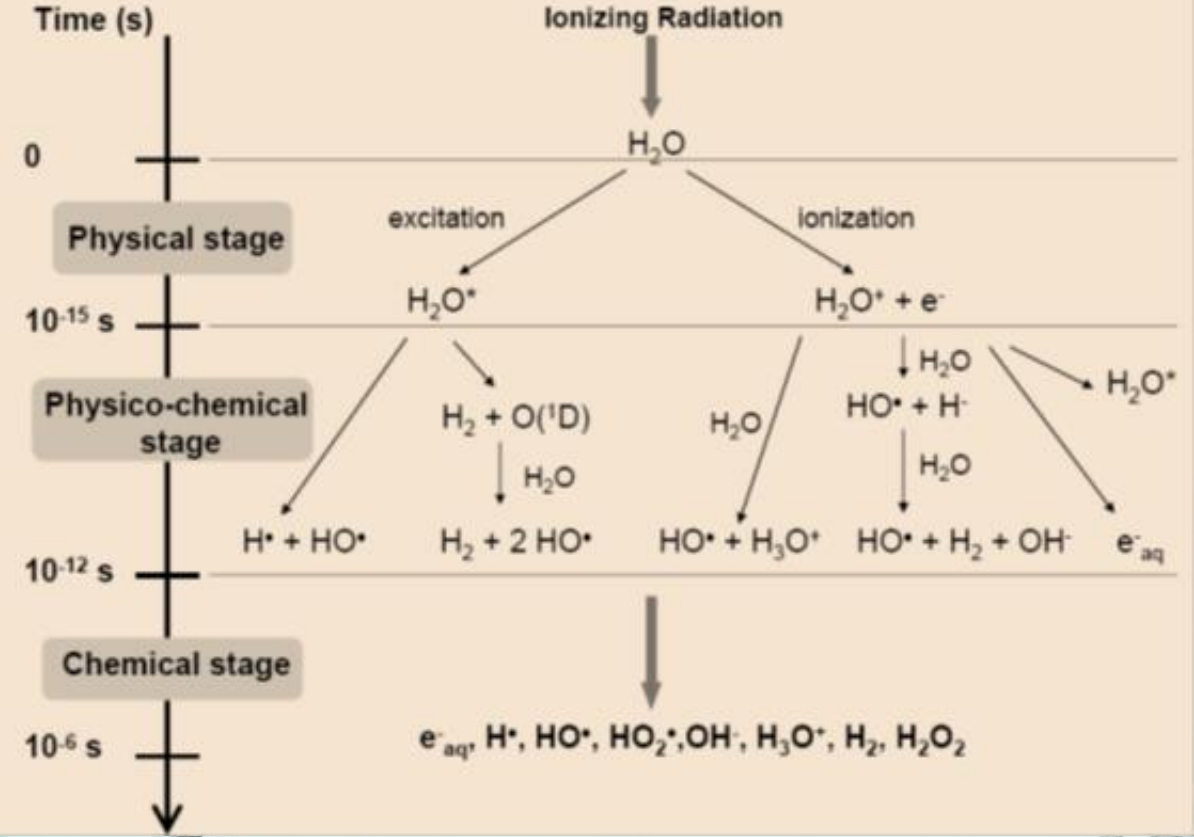
- ***About γ-ray radiation synthesis***
- ***Co-reduction synthesis of GO Sheet/AuNP composites***
- ***Group related works***
- ***Acknowledgments***

※ About γ-ray radiation synthesis

Principles : Irradiation of water by γ-ray



$$H_2O \xrightarrow{\gamma\text{-radiation}} H\bullet, \bullet OH, e^-_{aq}, H_3O^+, H_2, H_2O_2, HO_2, H_2O^*$$

Advantages of γ-radiation method

- → *Mild synthesis condition : room temp., ambient pressure;*
- → *No reduction or oxidation reagents;*
- → *No initiators, very pure products;*
- → *Reaction yield ;*
- → ……

The reaction products ***are uniformly distributed in the system***, and the particle size distribution of the products well done.

For inorganic/polymer composites: **the formation** of *nano-materials* and *polymers* ***can be synchronized (or one-step)***.

Many products to achieve industrial production: Teflon wire cable, dyeing and printing auxiliary, battery separator etc.

Synthesis system control

How to control the synthesis system with reductive surroundings?

—— *Reductive atmosphere(surroundings)*

Purging N_2 and adding iso-propanol or other kind of alcohols and to scavenge oxidative free radicals such as •OH, H_2O_2 etc.

$$(CH_3)_2CHOH + \bullet OH \rightarrow (CH_3)_2CHO\bullet + H_2O$$

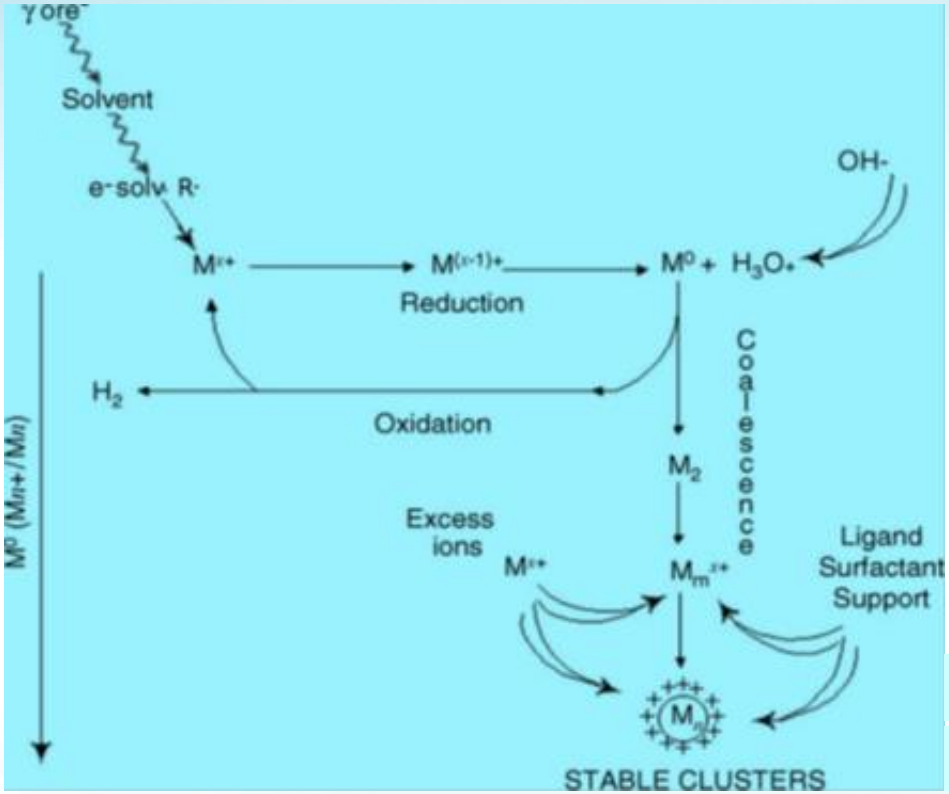
or $$(CH_3)_3COH + \bullet OH \rightarrow (CH_3)_3CO\bullet + H_2O$$

Main species in this case: e^-_{aq} , •H *and other reductive species*

e^-_{aq} *Redox potential (-2.77V)*

$$M^{n+} + e^-_{aq}(or \bullet H) \rightarrow M^{n-1} \xrightarrow{e^-_{aq}} M^{n-2} \xrightarrow{e^-_{aq}} \ldots M^0(nano-particle)$$
$$nM^0 \rightarrow M_n(Cluster)$$

$$G_{red}(\max) = G_{e_{aq}^-} + G_{H\bullet} + G_{OH\bullet} \approx 0.6\ \mu mol\ J^{-1}$$



$$M^0 + M^0 \rightarrow M_2$$

$$M_m + M_p \rightarrow M_n$$

How to control the synthesis system with oxidative surroundings?

——*Oxidative atmosphere(surroundings)*

Bubbling N_2O *about 10 min,* $e^-_{aq} + N_2O + H_2O \rightarrow N_2 + \bullet OH + OH^-$

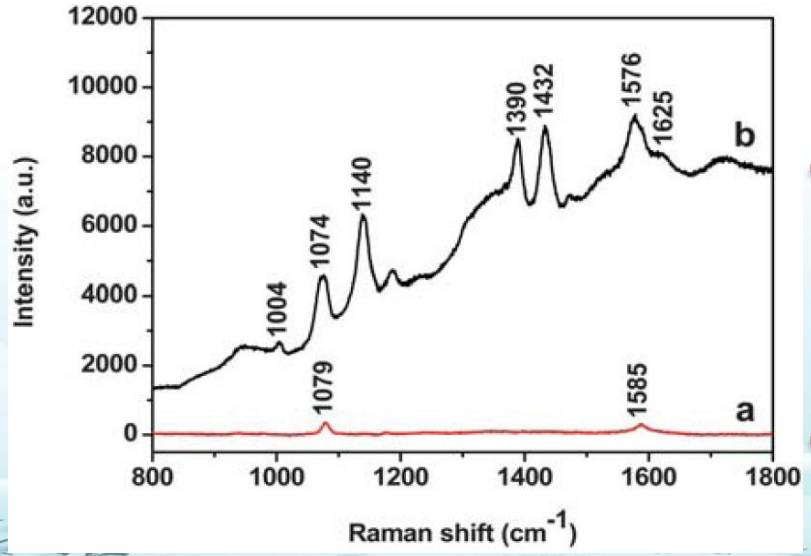
Main species in this case: $\bullet OH, H_2O_2$ *etc.* *Pulse radiolysis*

Why do we synthesize?

r-GO Sheet/Au NP Composites

GO/Noble-metal NP: optical, electrical and excellent catalytic performance

SERS Effect *surface-enhanced Raman scatting*



Au/GO

Au NP

※ Co-reduction synthesis of composites

Au^{3+}

isopropanol

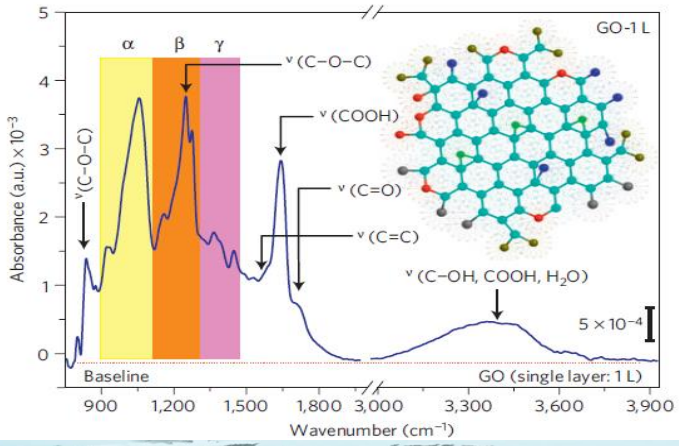
GO

γ-ray

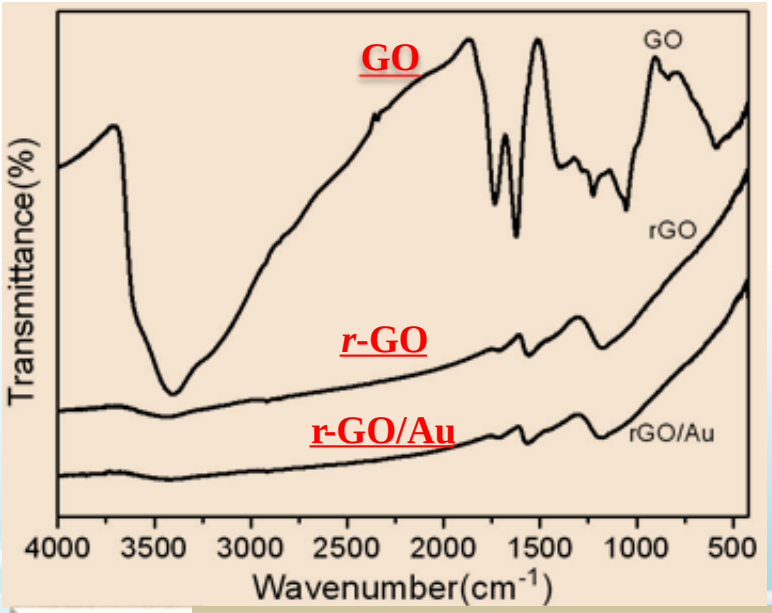
r-GO/AuNP Composite

$HAuCl_4$
Chloroauric acid

GO *r*-GO



NATURE MATERIALS DOI: 10.1038/NMAT2858



FT-IR

Fig: *Most of the oxygen-containing groups had been removed after irradiation.*

Unpublished work

※ Co-reduction synthesis of composites

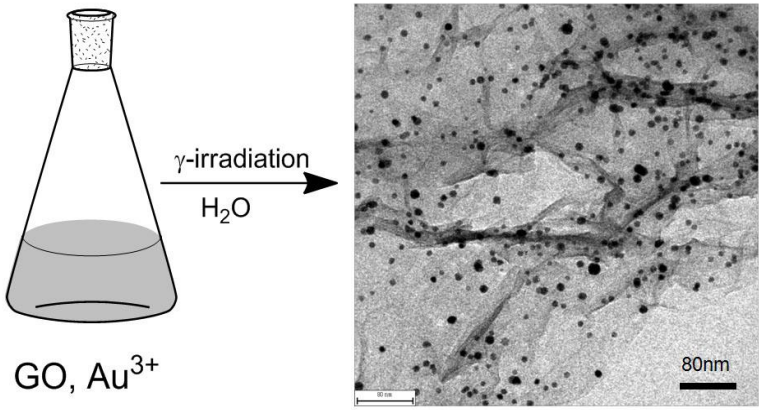
Au^{3+}

isopropanol

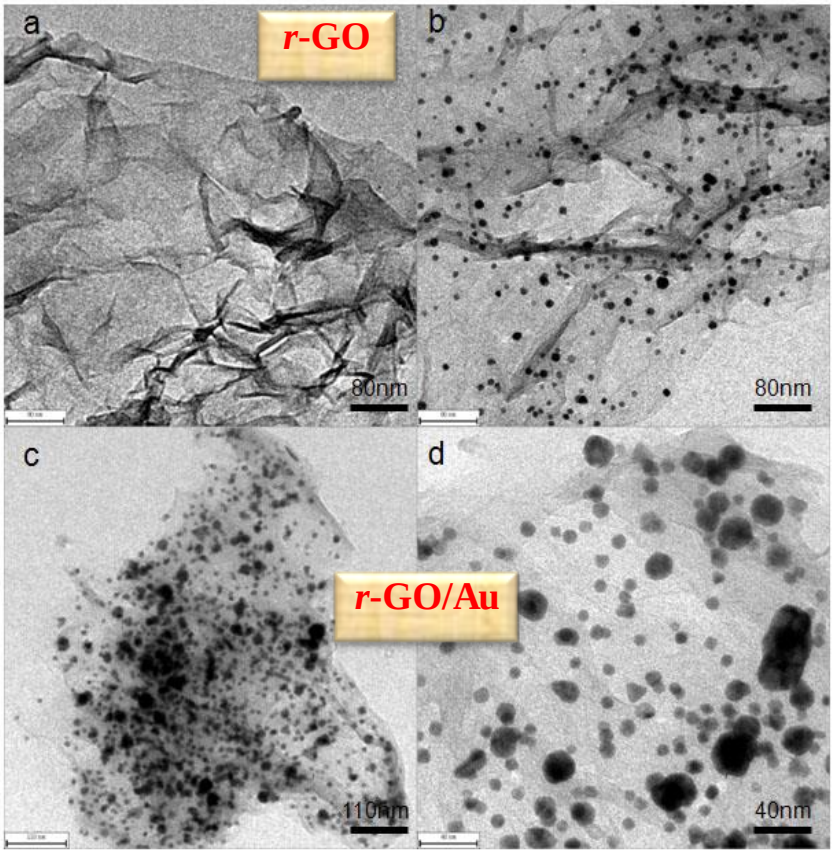
GO

γ-ray

***r*-GO *Sheet*/Au*NP* Composite**



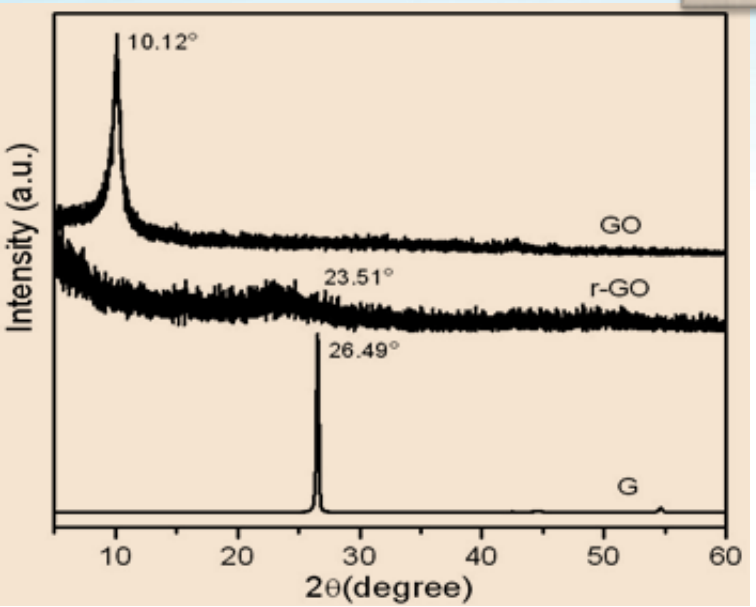
Preparation of r-GO/Au nanocomposite through γ-irradiation



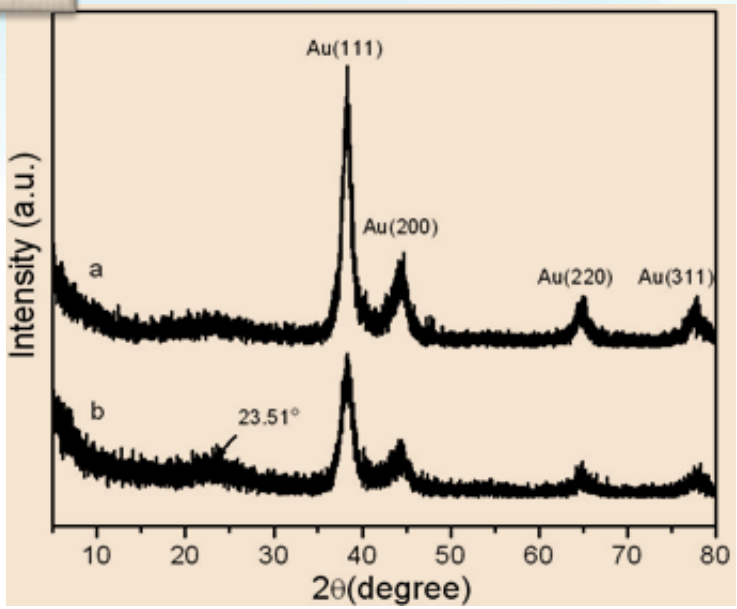
TEM of r-GO/AuNP At different concentr. of Au^{3+} (b, c, d)

Unpublished work

XRD



G, GO and *r*-GO



r-GO/AuNP

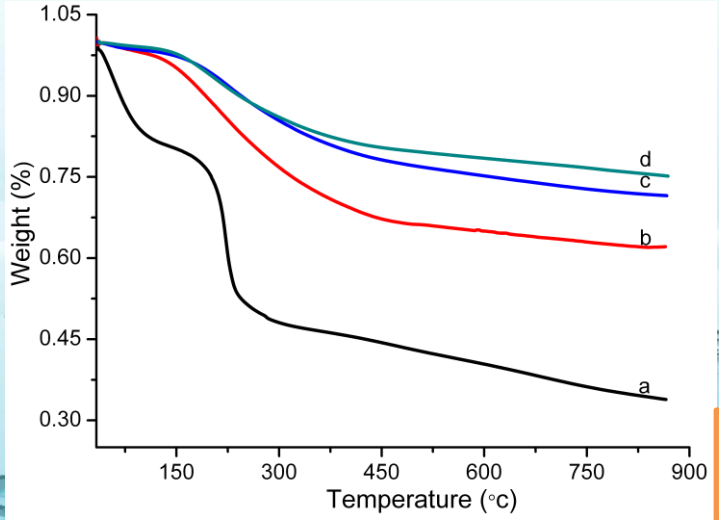
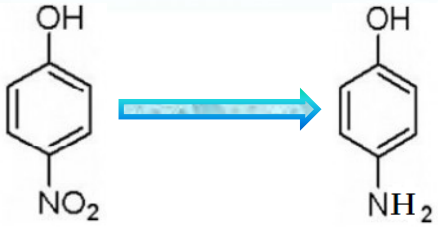


Fig. The TGA spectra of GO (a), r-GO (b), r-GO Sheet/Au (c,d)

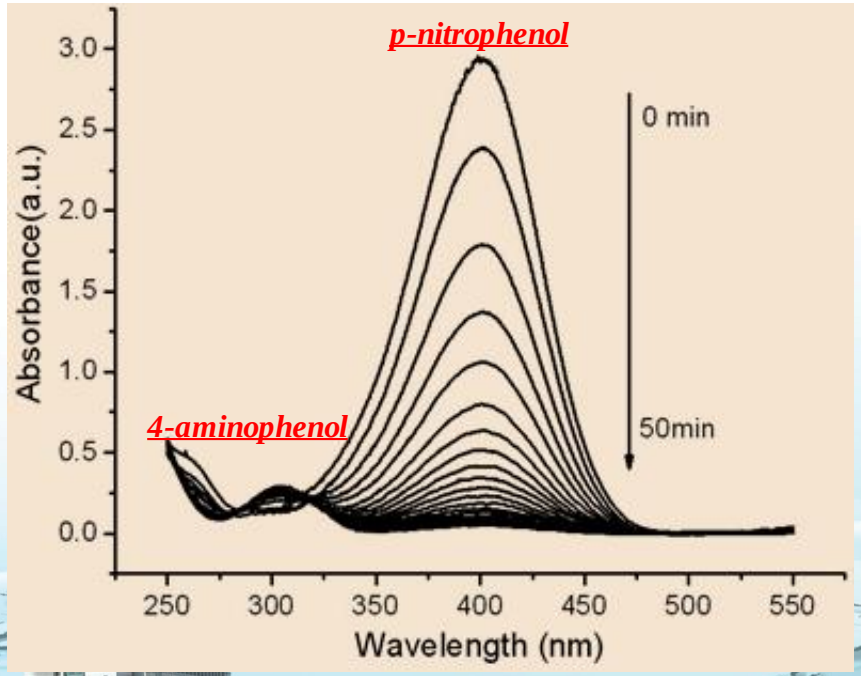
Unpublished work

Catalytic property study: r-GO/AuNP composite

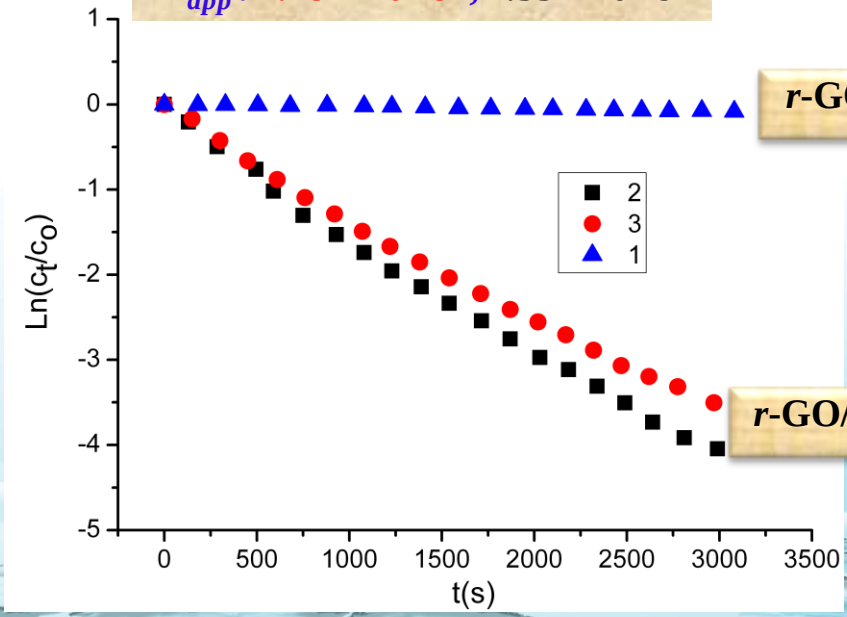
Catalytic reduction of p-nitrophenol by $NaBH_4$ (sodium borohydride)



$$-\frac{dc_t}{dt} = k_{app} c_t$$



k_{app}: $1.18\times10^{-3}\ s^{-1}$, $1.35\times10^{-3}\ s^{-1}$

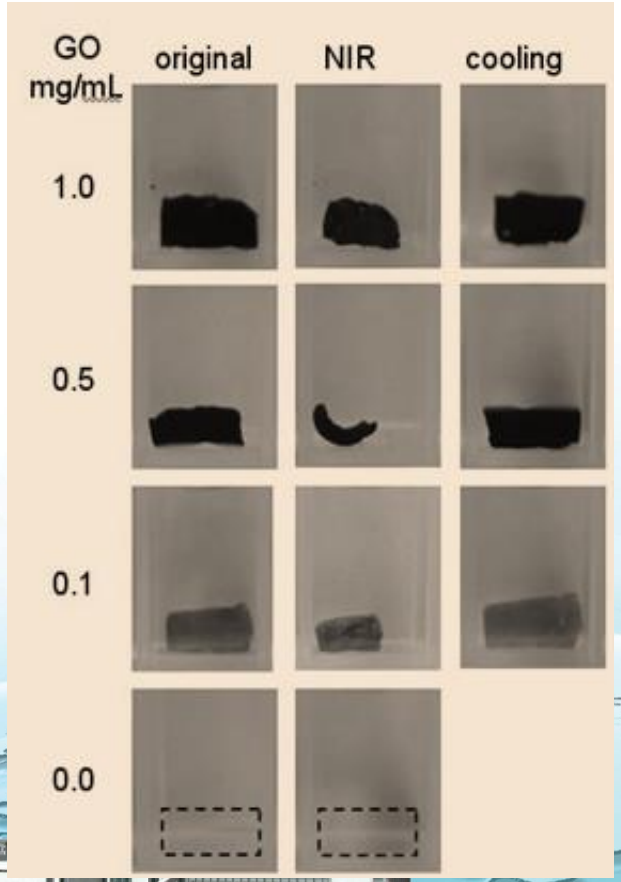


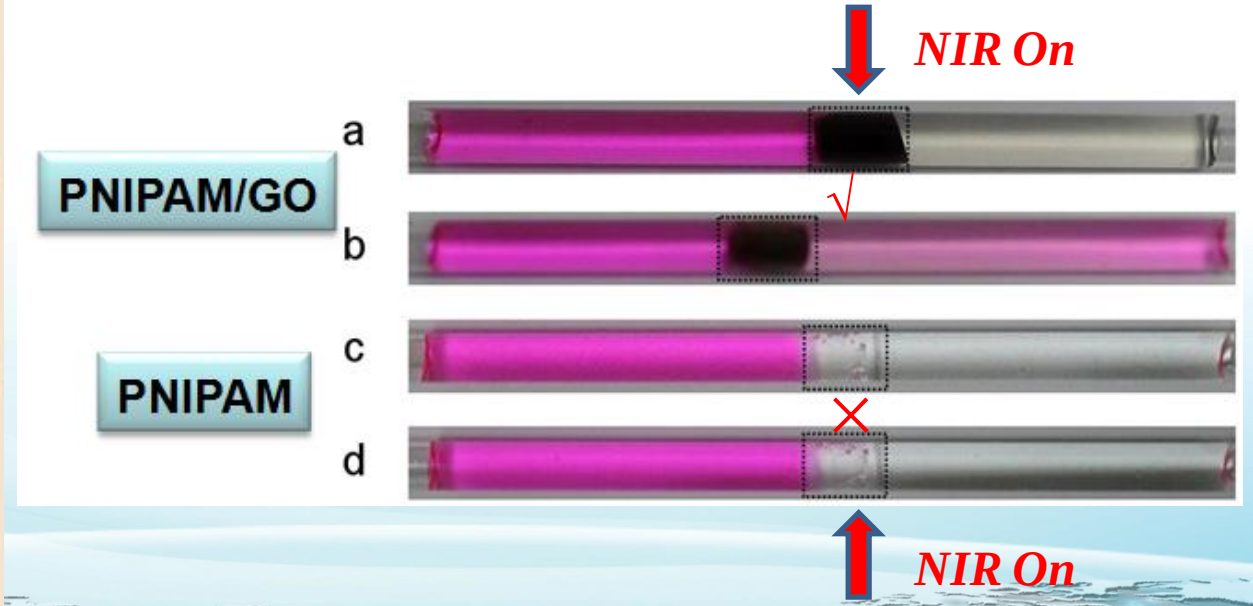
Unpublished work

※ Group related works

Photo-thermal sensitive PNIPAM/GO nanocomposite hydrogel

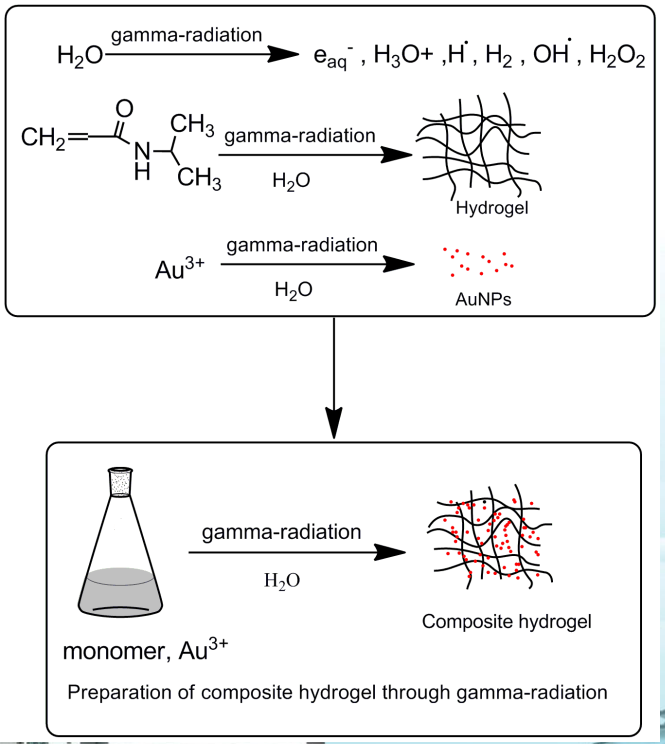
by in situ γ-radiation-assisted polymerization of aqueous solution of N-isopropylacrylamide and graphene oxide,



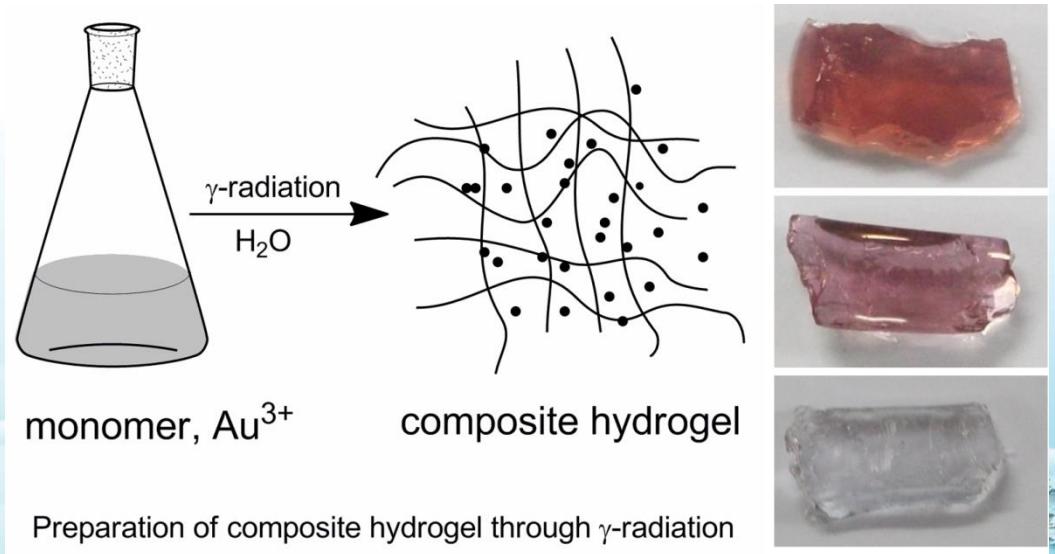


※ Group related works

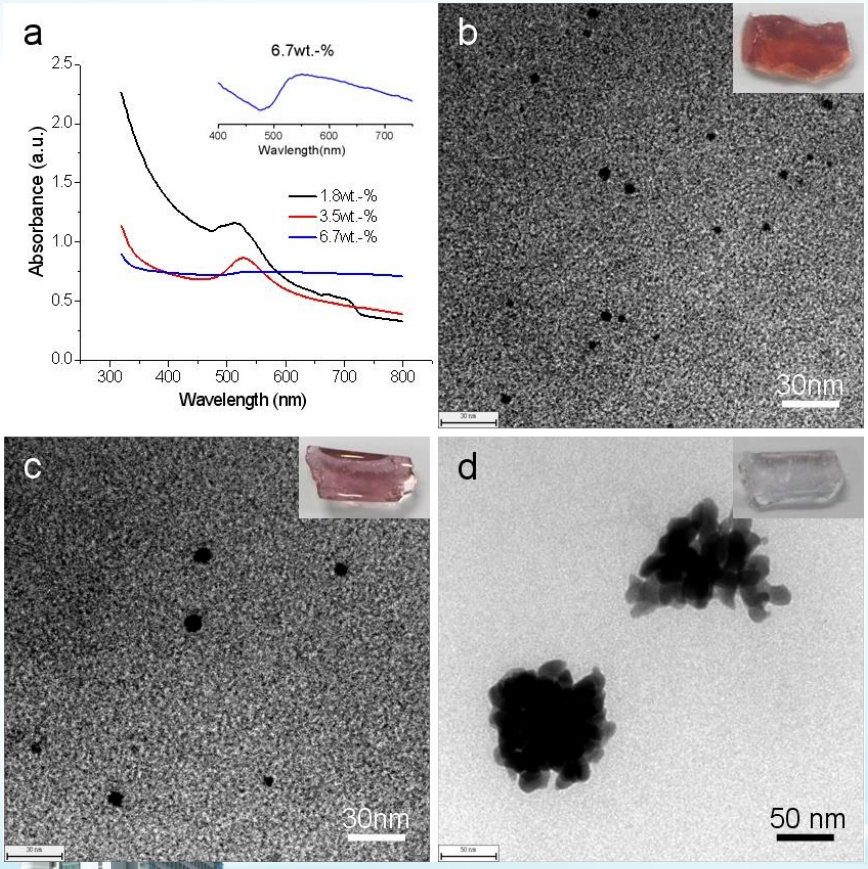
Thermosensitive poly (N-isopropylacrylamide)/Au nanoparticles (PNIPAM/Au NPs) nanocomposite hydrogels (One-step)

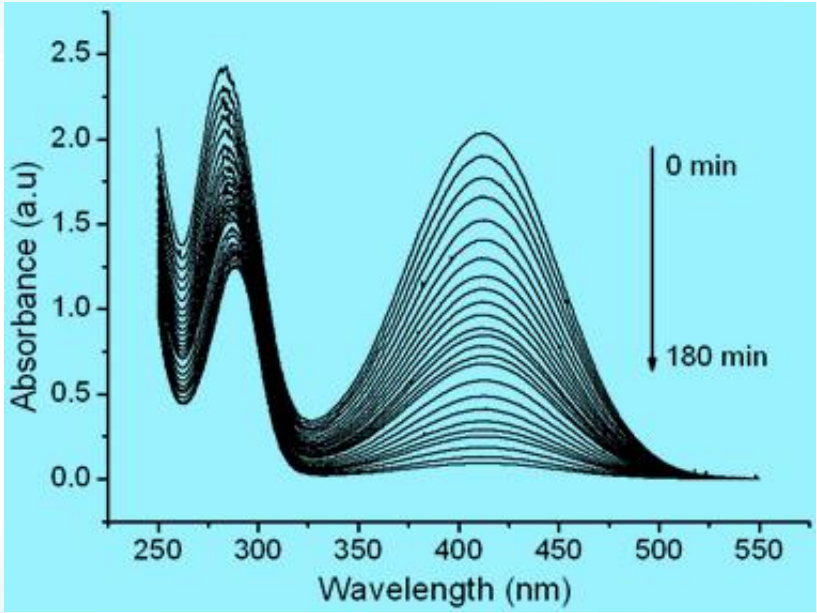


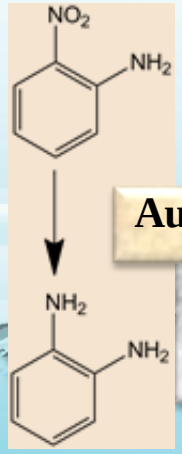
excellent catalytic performance



※ Group related works







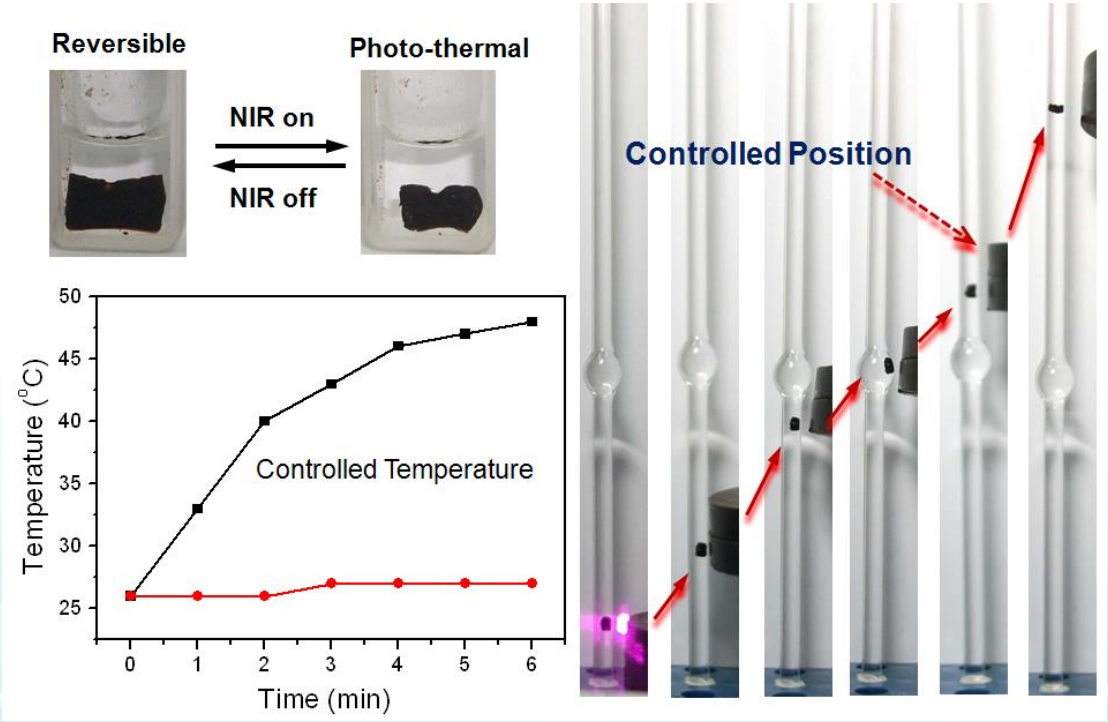
excellent catalytic performance

Au *NP*

Reaction time ↑, absorbance ↓,
o-nitroaniline was reduced.

※ Group related works

$PNIPAM/Fe_3O_4$ Ferromagnetic hydrogel



※ Acknowledgments

Dr. Chunhua Zhu and Dr. Zibin Hai

Collaborator: Prof. Shuhong Yu

NSFC,

MOE：the Specialized Research Fund for the Doctoral Program of Higher Education

Thank you for your attention!