



In situ and facile green synthesis of Gold-Reduced Graphene Oxide using Betel leaf extract for catalytic reduction of 4-Nitrophenol.

Syed Akhil, Basavaiah Chandu*

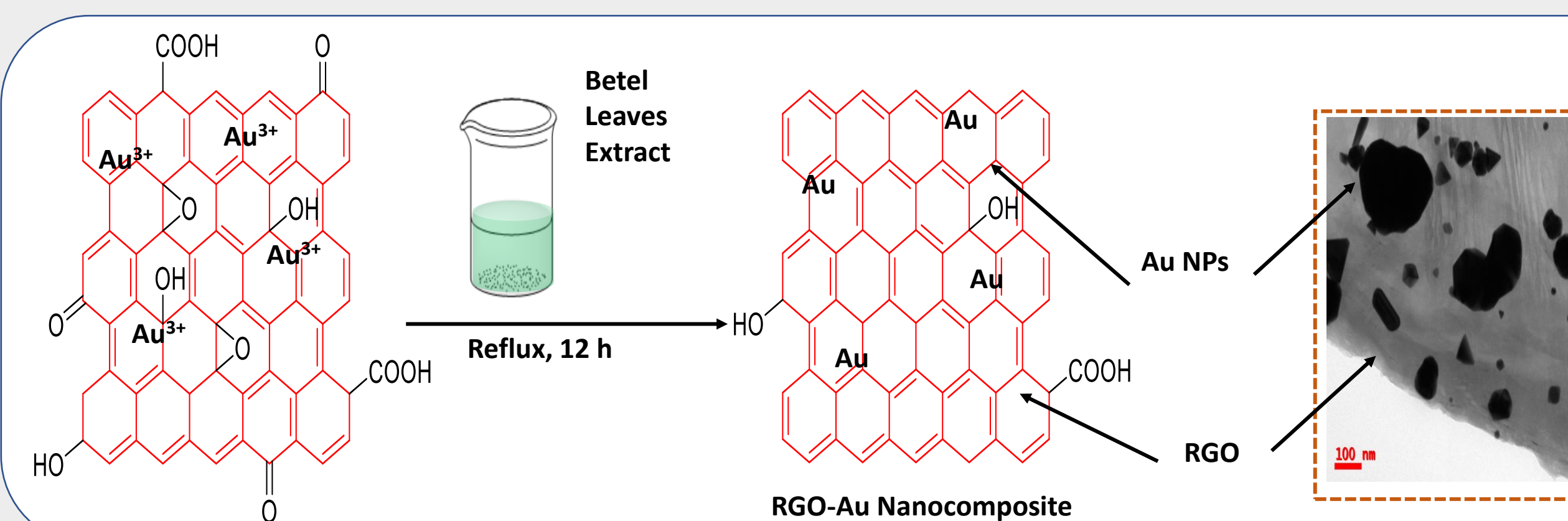
Department of Nanotechnology, Acharya Nagarjuna University, Guntur, A. P. India-522510



Introduction

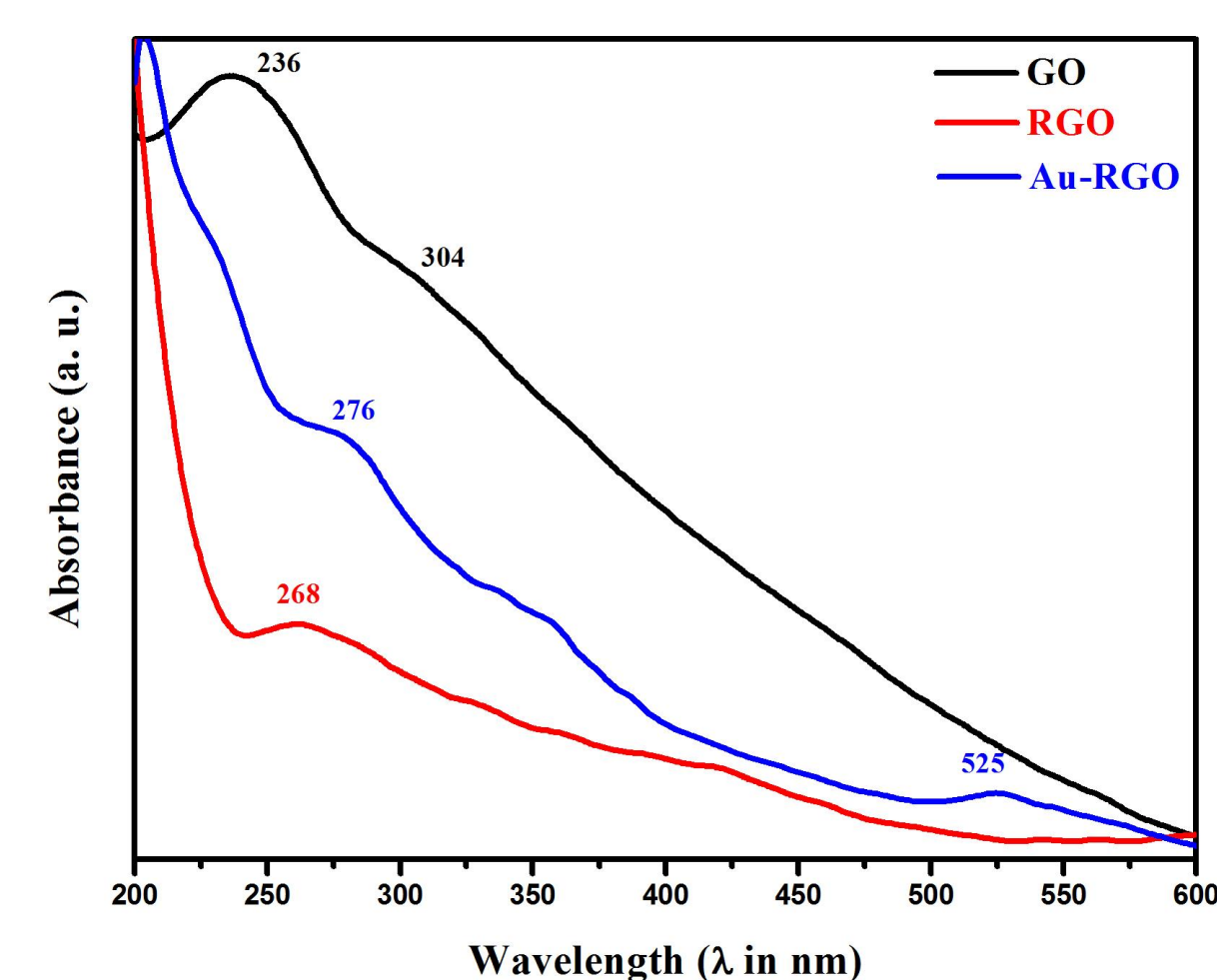
- ❖ The graphene driven gold rush in the recent literature is due to its remarkable thermal, mechanical, electrical, optical, catalytic properties that realized the myriad applications in catalysis, electronics, batteries, sensors, energy materials, biosensing, diagnostics, therapeutics etc.
- ❖ Graphene-metal nanocomposites are very attractive due to their improved stability and properties resulting from the synergistic effects at the interface of graphene and metal particles.
- ❖ 4-nitrophenol (4-NP) is a refractory pollutant in industrial effluents with profound implications on the liver, kidney and central nervous system.
- ❖ Catalytic reduction of 4-NP into 4-aminophenol (4-AP, a pharmaceutical intermediate), is highly appreciated to reduce the 4-NP pollution and converting to a beneficial material
- ❖ Graphene-gold nanocomposite with huge specific surface area, π - π conjugation, excellent charge transfer capability, high chemical and mechanical stability, imparts catalyst stability, increased catalytic efficiency emerged as an alternate catalyst system for conversion of 4-NP to 4-AP.

Synthesis

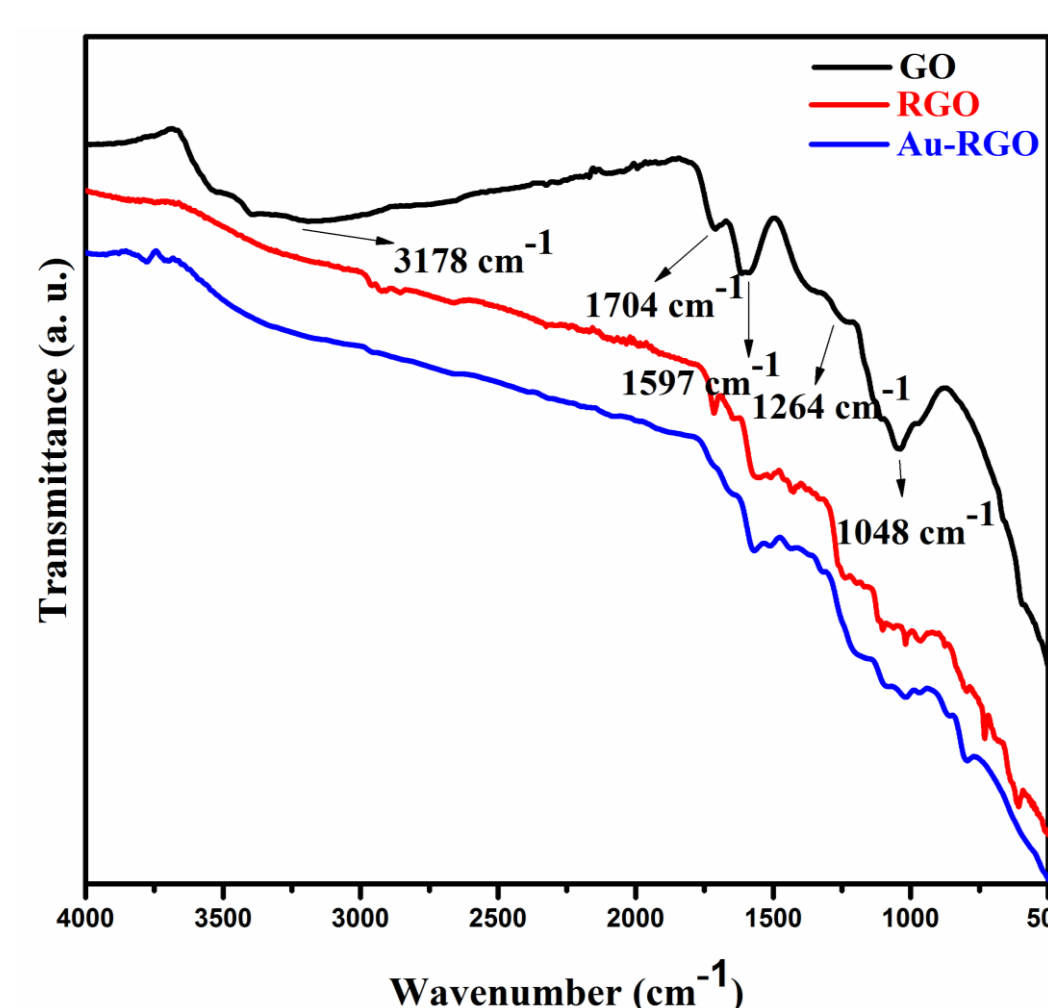


- Betel leaves extract (BLE) was prepared by refluxing 100 g of fresh leaves, graphene oxide (GO) was prepared using Hummers method.
- The precursor solution was made by dispersion of 100 mg of GO and 10 mg of the HAuCl_4 in 100 mL of water by sonication.
- The precursor solution was mixed with 100 mL of BLE in an RB flask and refluxed for 12 h at 100 °C. The yellow coloured GO dispersion was converted to black colour indicating the formation of RGO-Au nanocomposite.

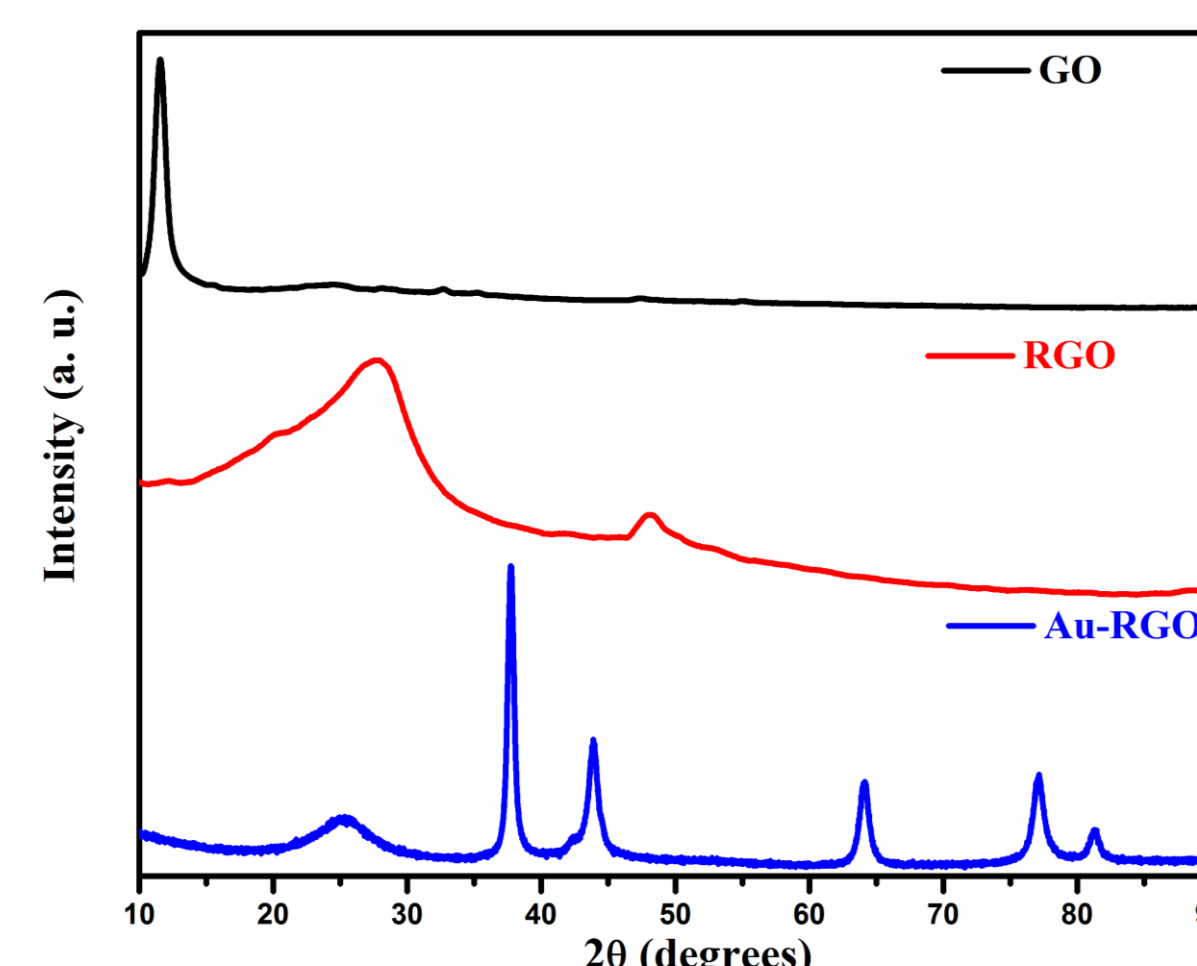
Structural Characterization



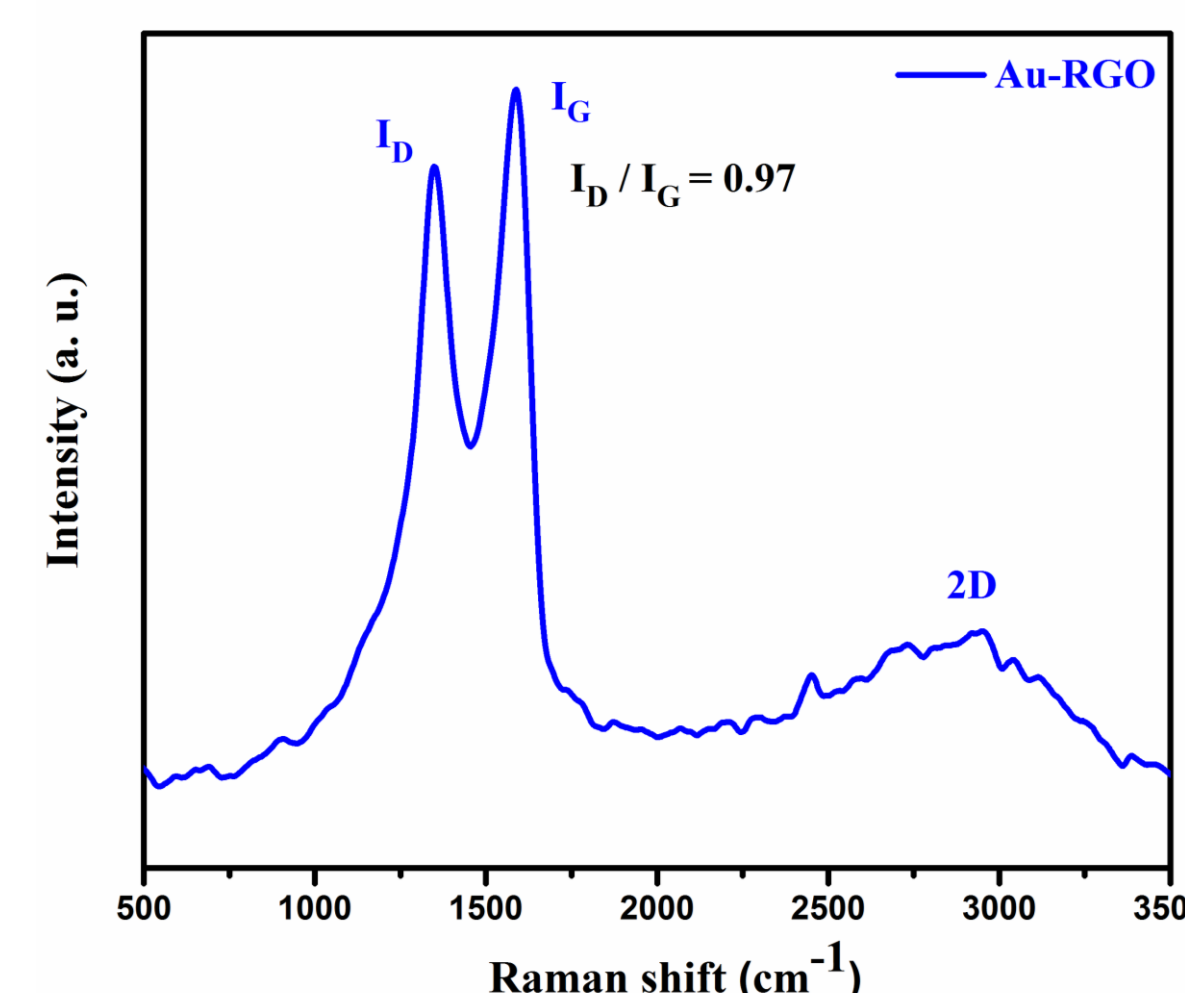
UV-Visible spectra showed graphene peak at 268 nm and Au NPs peak at 525 nm.



The FT-IR spectra showed the decrease in the intensities of the GO peaks.



The XRD showed the peaks at 25° for graphene, 37.7°, 43.8°, 64.1° and 77.1° for Au NPs.



The Raman spectra showed both D and G bands at 1351 cm^{-1} & 1590 cm^{-1}



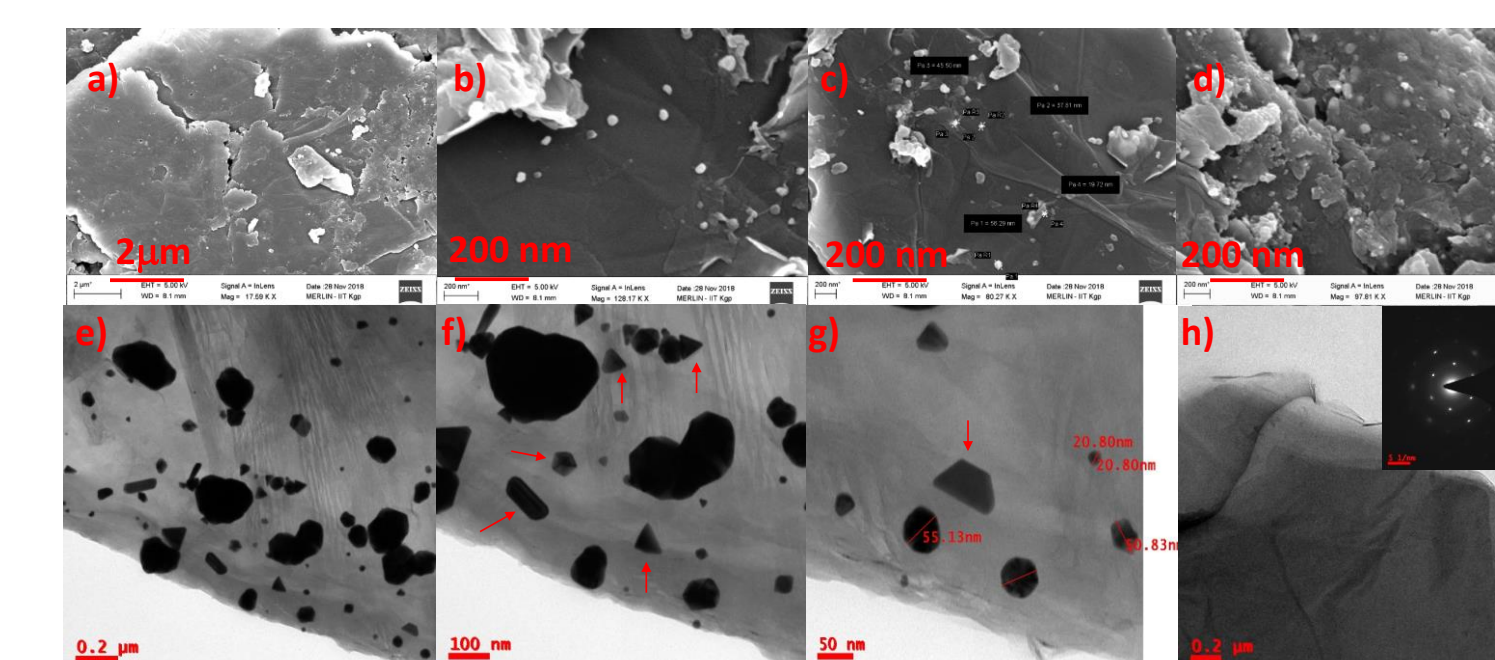
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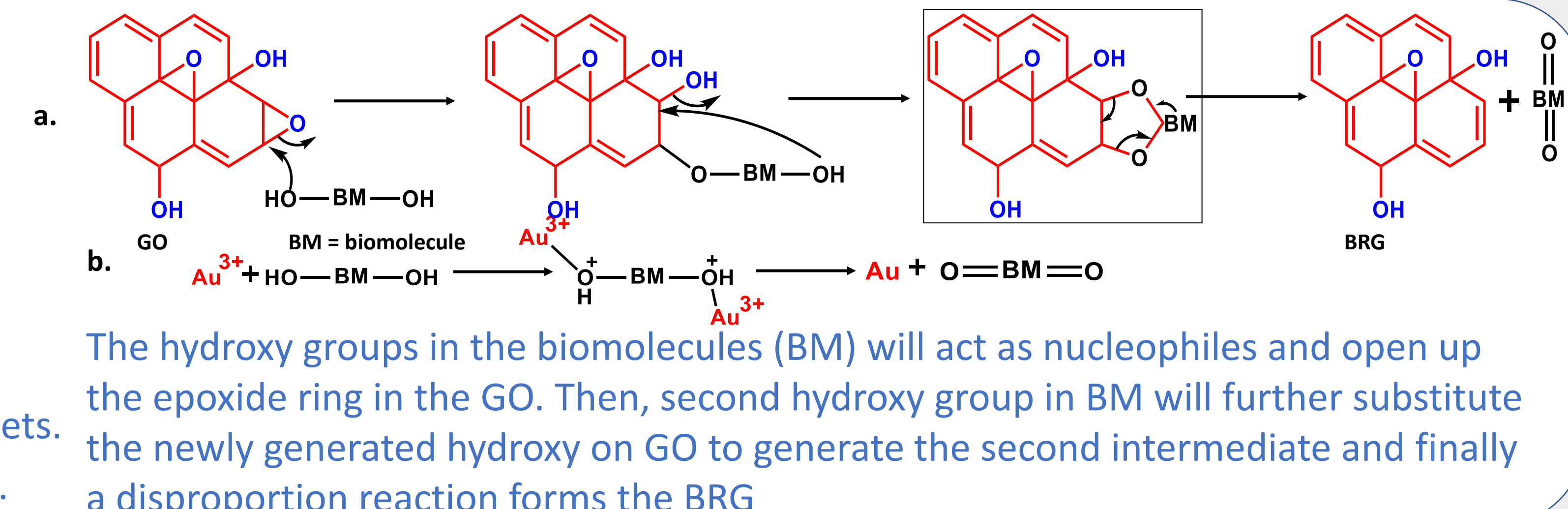


Topographic information

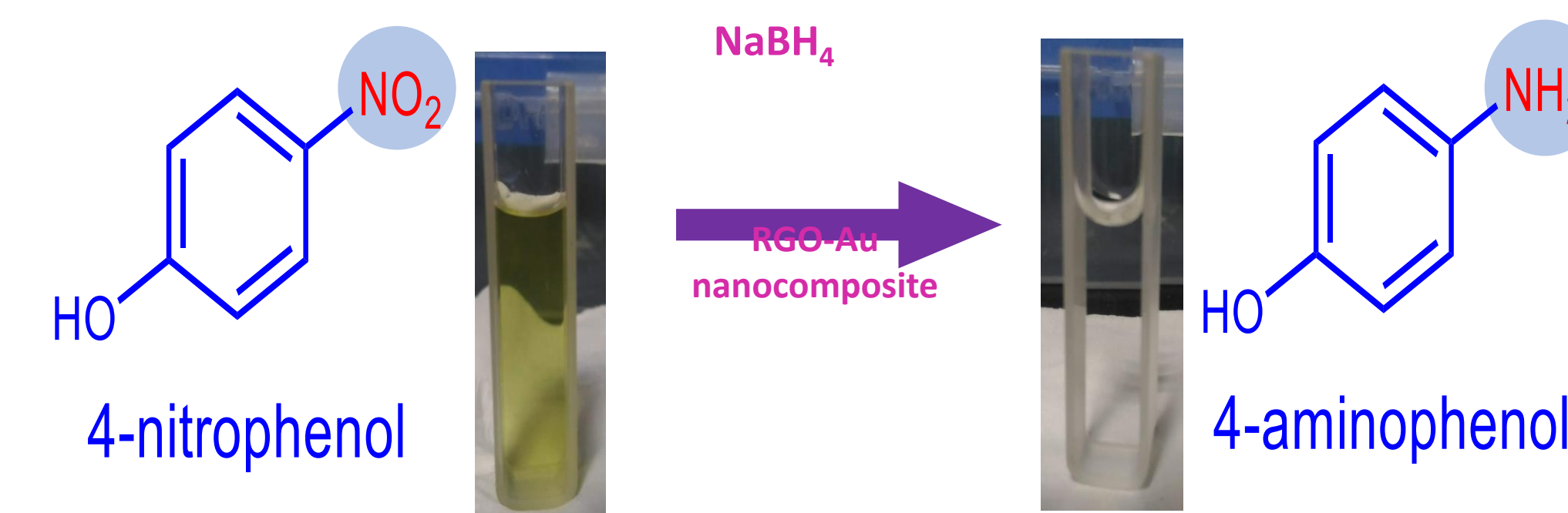


- FESEM and TEM images of the nanocomposite.
- Well stabilized Au NPs distributed on graphene sheets.
- The size of Au NPs were in the range of 20 – 50 nm.

Mechanism of GO reduction to RGO

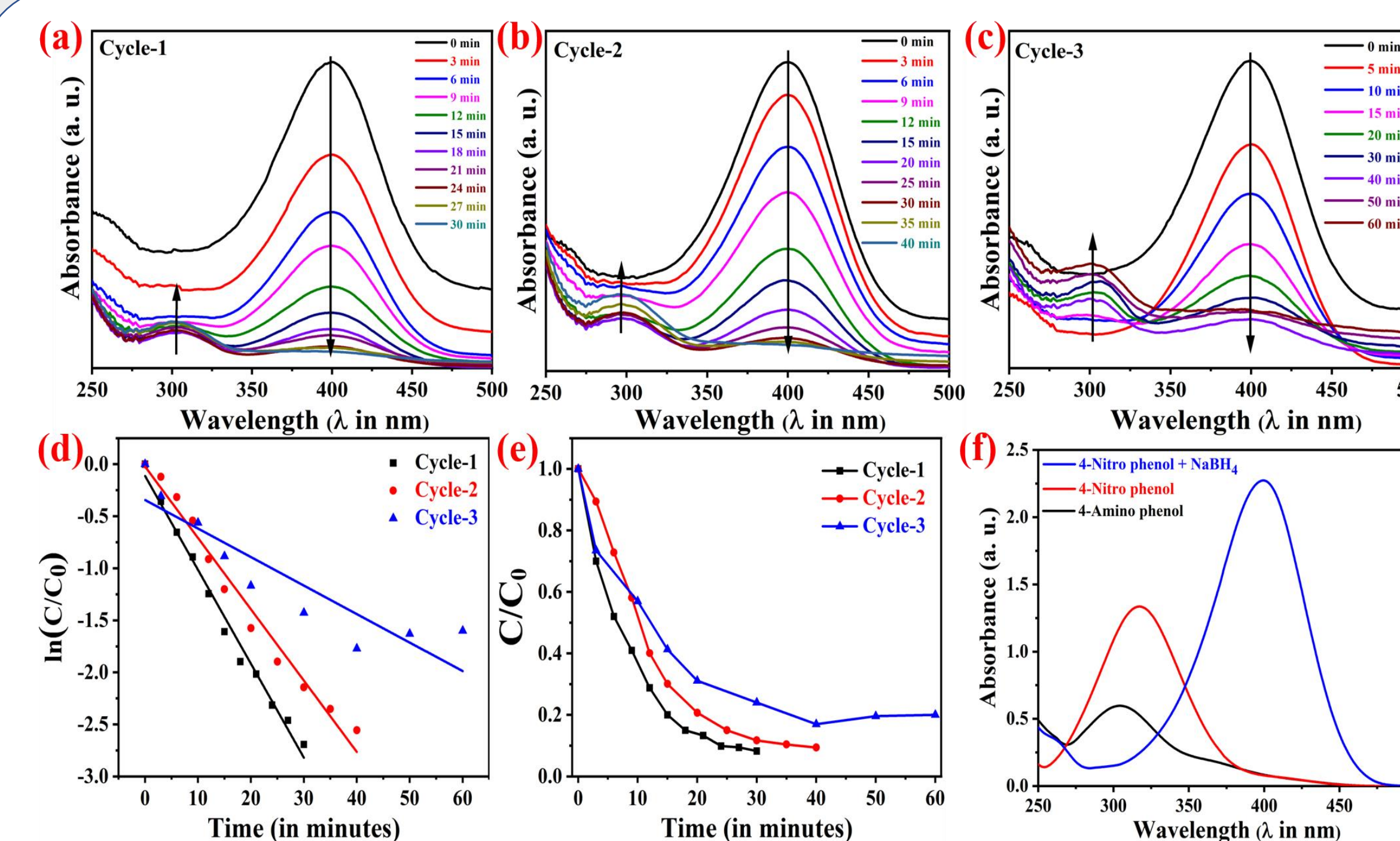


4-Nitrophenol reduction



- 4-NP (0.5 mM, 25 mL), freshly prepared NaBH_4 (0.1 M, 20 mL) and RGO-Au nanocomposite dispersion (5 mL with 0.25 mg/mL concentration) were added and the reaction mixture was stirred at room temperature.
- For every 2 min, the concentration of 4-NP was monitored by variations in the UV-visible absorption maximum at 400 nm.
- The nanocomposite was recovered through centrifugation and re-dispersed immediately for the next cycle.

4-Nitrophenol reduction Kinetics



Kinetics of reduction of 4-nitrophenol into 4-aminophenol. (a-c) three cycles (d) $\ln C/C_0$ Vs time graph (e) C/C_0 Vs time graph (f) The clear UV-Visible changes for 4-NP, 4-NP+ NaBH_4 and 4-AP.

Conclusions

- ❖ Green synthesis of graphene-Au nanocomposite was achieved.
- ❖ RGO-Au nanocomposite exhibited superior catalytic efficiency in reduction of 4-nitrophenol to 4-aminophenol with in 30 min in the first cycle.
- ❖ The present strategy successfully demonstrated the use of green reagents in the synthesis, conversion of polluting molecule 4-NP into economy 4-AP.
- ❖ RGO-Au nanocomposite may be applied in catalysis reactions.

References

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Presenting author: Dr Basavaiah Chandu | chandupcu@gmail.com