Biosynthesis of Silver Nanoparticles doped on CNTs for the adsorption of Selected Heavy Metals from Mine Wastewater

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Introduction

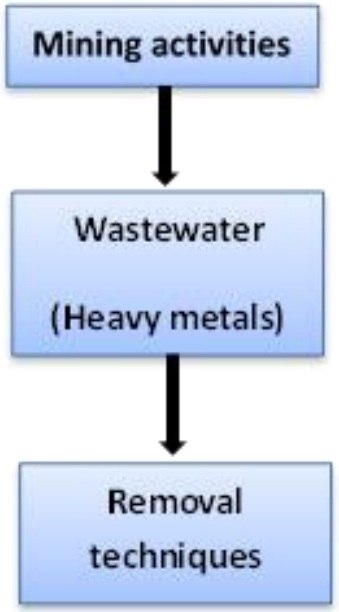

Fig. 1: A miner using a sluicing machine

Fig. 2: Land pollution

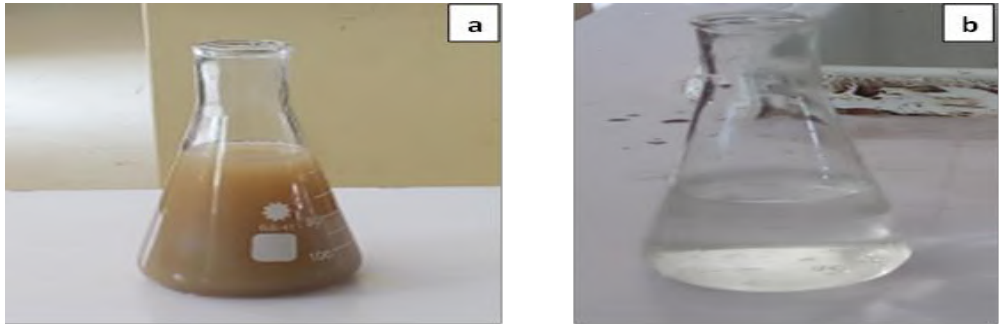

Fig. 3: Wastewater samples (a) before treatment (b) after treatment with CNT/AgNPs nanocomposite

Fig. 4: toxic effects of selected heavy metals

Objectives

- Synthesis silver nanoparticles (AgNPs) using green route
- Synthesis carbon nanotubes (CNTs) by catalytic chemical vapour deposition (CCVD) technique.
- Preparation of CNTs/Ag nanoparticles nanocomposite by using the combination of green route and CCVD method.
- Characterise the CNT, AgNPs and their nanocomposite using Ultraviolet–Visible Spectroscopy (Uv–Vis), High Resolution Scanning Electron Microscope (HRSEM), Fourier Transform Infrared (FTIR) and X-Ray Diffraction (XRD).
- Physico-chemical characterization of the metals before and after the batch adsorption process

Methodology

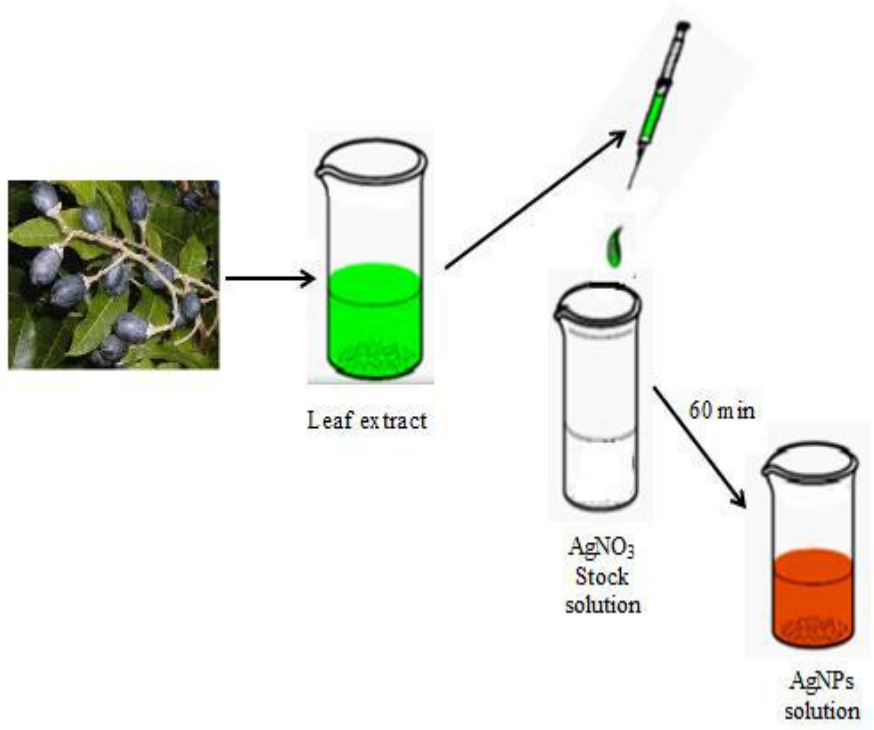

Fig. 5 : Synthesis of silver nanoparticles

- Synthesis of silver nanoparticles (AgNPs) using green route method.
- Synthesis of carbon nanotubes (CNTs) by catalytic chemical vapour deposition (CCVD) technique.
- Preparation of CNTs/AgNPs nanocomposite by mixing the CNTs and Ag in same ratios. Drying of the composite then the sample ready for characterization.

Experimental Setting

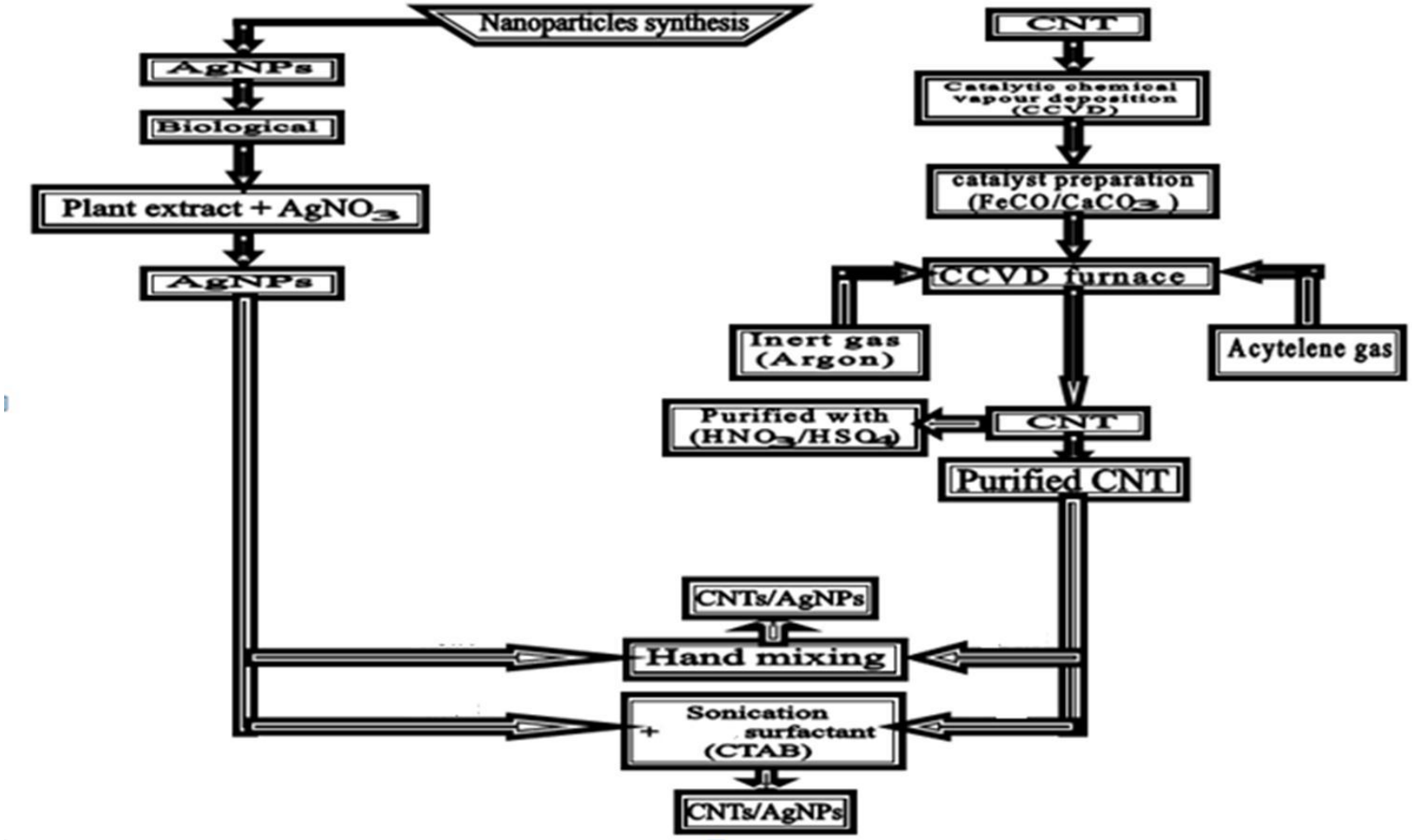

Fig. 6 : Experimental flow chart of producing CNTs/AgNPs composite

Results and Discussion

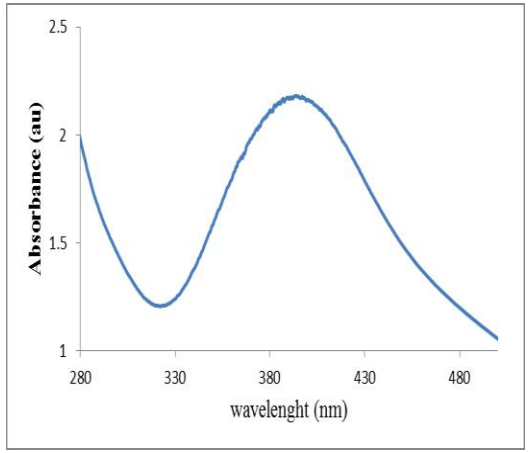

Fig. 7: UV-Visible absorption spectrum of AgNPs (Reveal characteristic Plasmon resonance absorption peaks of the Ag located at 391 nm, for 1.13 mM)

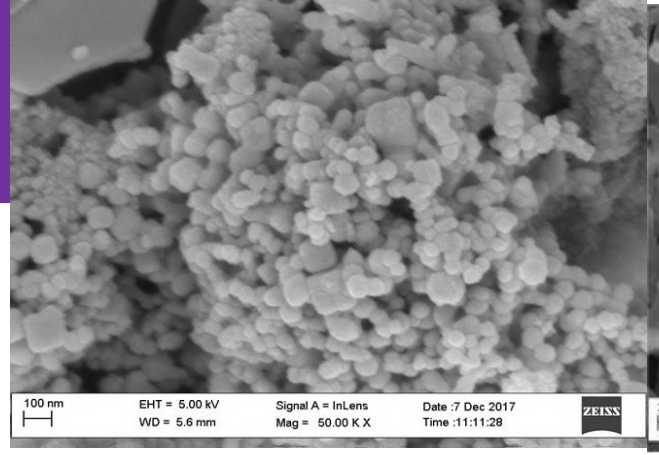

Fig. 8: HRSEM image of synthesized AgNPs

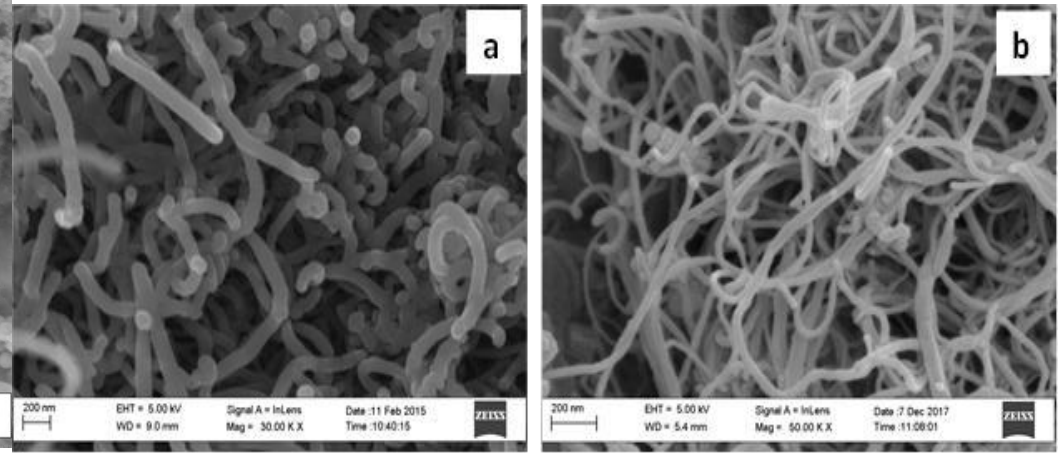

Fig. 9 :HRSEM image of (a) CNT (b) CNT/AgNPs composite

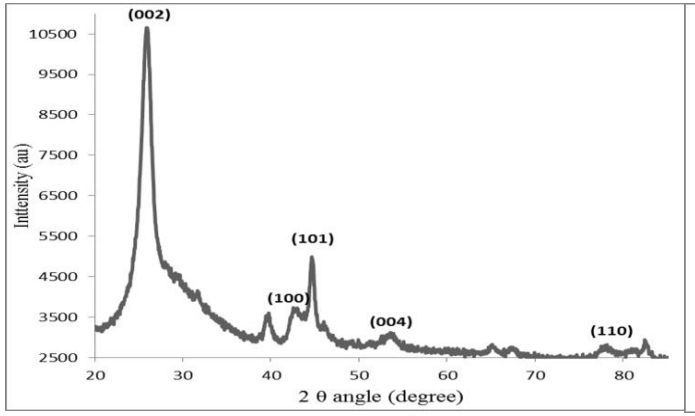

Fig. 10: X- Rays diffraction analysis (XRD) of CNT

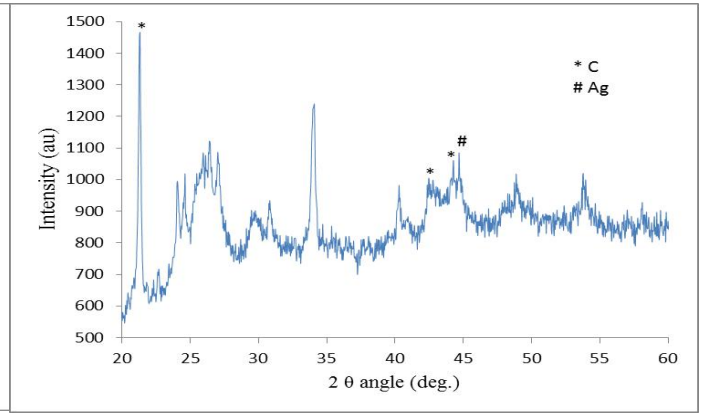

Fig. 11: X- Rays diffraction analysis (XRD) of CNT/AgNPs nanocomposite

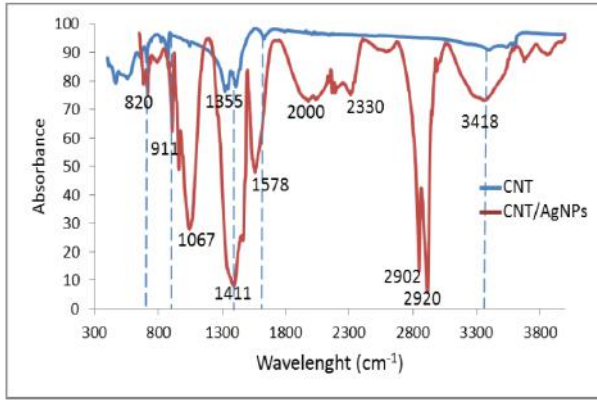

Fig. 12: FTIR analysis CNTs and CNTs/AgNPs composite

Table 1: Brunauer-Emmett-Teller (BET) analysis of MWCNTs and CNTs/AgNPs composite

	Total surface area (m^2/g)	Pore size (cm^3/g)	Pore volume (nm)
MWCNTs	158.5	0.8931	35.61
CNTs/AgNPs	145.20	0.8859	32.96

Results and Discussion

Effect of contact time on treatment with MWCNTs and CNTs/AgNPs composite

Adsorption experiment

- 50cm^3 of the mine wastewater.
- 0.1 g of the MWCNTs (or CNT/AgNPs)
- shaken on a shaker at stirring speed of 200 rpm for 60 mins

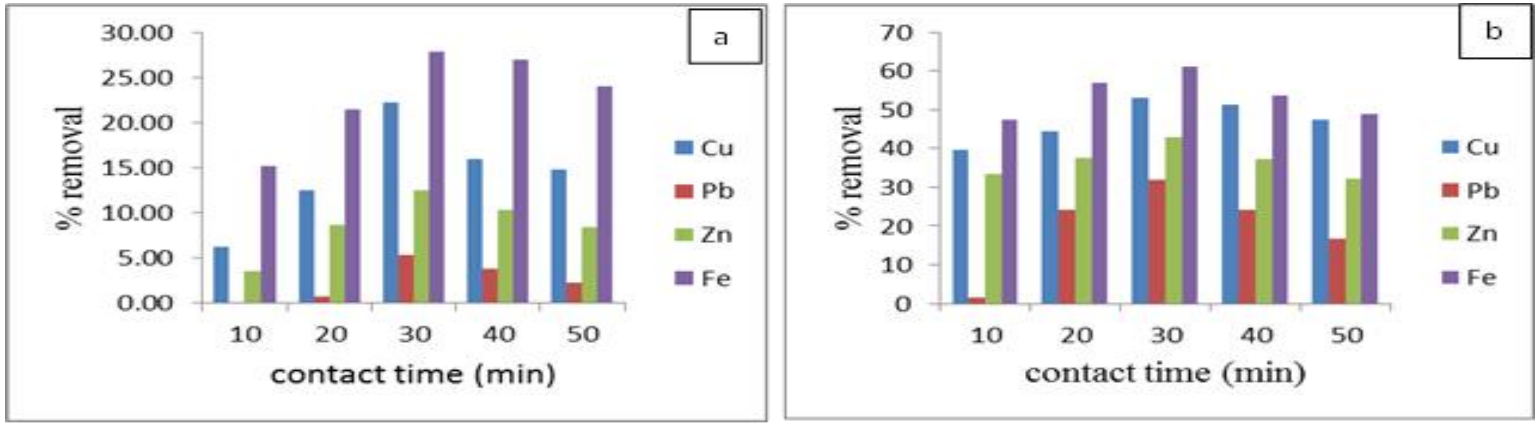

Fig. 13: Percentage of Cu, Pb, Zn, and Fe removed from mine wastewater at 0.1 g adsorbent dosage using (a) MWCNTs (b) CNTs/AgNPs nanocomposite

Table 2: Concentration of Cu, Pb, Zn, and Fe in mine wastewater and their permissible limit by NIS 2007

Metals	Effluents (mg/L)	Permissible limit by NIS (2007) (mg/L)
Cu	2.57	1.000
Pb	1.32	0.010
Zn	3.68	3.000
Fe	2.37	0.300

Table 3: Comparison of the Result of effect of contact time using MWCNT on the removal of Cu, Pb, Zn and Fe with NIS, 2007 Standard (Permissible Limit)

Heavy metals (mg/L)	Time (mins.)					
	From source	10	20	30	40	50
Cu	2.57	2.41	2.25	2.00	2.16	2.19
Pb	1.32	1.32	1.31	1.25	1.27	1.29
Zn	3.68	3.55	3.36	3.22	3.30	3.37
Fe	2.37	2.01	1.86	1.71	1.73	1.80

Table 4: Comparison of the Result of effect of contact time using MWCNT on the removal of Cu, Pb, Zn and Fe with NIS, 2007 Standard (Permissible Limit)

Heavy metals (mg/L)	Time (mins.)					
	From source	10	20	30	40	50
Cu	2.57	1.55	1.43	1.21	1.25	1.35
Pb	1.32	1.30	1.00	0.90	1.00	1.10
Zn	3.68	2.45	2.30	2.10	2.31	2.50
Fe	2.37	1.25	1.02	0.92	1.10	1.21

Conclusions & Recommendations

Conclusions

- Carbon nanotubes (CNTs) were successfully prepared by catalytic chemical vapour deposition (CCVD) technique.
- Silver nanoparticle were successfully prepared via green route method. The nanoparticles prepared by this method were highly of crystalline spherical shape nanoparticles of FCC structure same as that of the bulk material.
- Preparation of CNT/AgNPs nanocomposite was achieved with an average size distribution of AgNPs on the MWCNTs to be approximately 8.9 nm and surface area of 145.20m^2/g as confirmed from the BET result.
- The adsorption of Cu, Pb, Zn and Fe onto CNT/AgNPs composite was greatly influenced by contact time.
- The maximum removal efficiency of CNTs/AgNPs composites for Fe, Cu, Zn and Pb under the applied conditions was greater than MWCNTs alone indicating the order of percentage removal of the selected heavy metals as follows: Fe>Cu>Zn>Pb.

Conclusions & Recommendations

Recommendations

- Other adsorption parameter such as particle size, stirring speed, should be investigated.
- Silver nanoparticles are soluble in water; hence the concentration dissolve silver nanoparticles should be investigated in the mine wastewater after treatment and Microbial activity of silver nanoparticles should also be carried out.
- Other heavy metals such as Cadmium, Chromium, Nickel and Mercury should also be investigated.

References

- Text

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