Synthesis and characterization of copper oxide nanoparticles by solution combustion method and Study of Antibacterial Activities of CuO Nanoparticles

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Abstract: Copper oxide nanoparticles were synthesized by solution combustion method by using copper nitrate. The copper oxide nanoparticles were characterized by UV-Visible spectra, Ray diffraction (XRD), Scanning Electron Microscope (SEM), The UV – Visible spectra revels that the band gap energy copper oxide nanoparticles is 2.24eV using Tauc plot. The XRD pattern shows that the synthesized copper oxide nanoparticles were pure and nano-sized, The SEM image revels that the copper oxide nanoparticles were spherical shape.

Keywords: Copper oxide nanoparticles, solution combustion method, Antibacterial Activity.

I. Introduction:

Nanoparticles are the most fundamental components in the fabrication of a nanostructure. Novel properties of nanoparticles are gaining increasing attention of the researchers [1, 2] the oxides of transition metals are an important class of semiconductors, which have applications in magnetic storage media, solar energy transformation, electronics and catalysis. Among the oxides of transition metals, copper oxide nanoparticles are of special interest because of their efficiency as Nano fluids in heat transfer application[3-5].Copper oxide (CuO) is one of potential p-type semiconductors and gains considerable attentions due to its excellent optical, electrical, physical, and magnetic properties. CuO with narrow band gap of 1.2 eV is extensively used in various applications such as catalysis [6]. The copper oxide nanoparticles (CuO-NPs) possess a wide range of applications. Compared with ordinary copper oxide powder, the nano particles of copper oxide show superior catalytic activity and selectivity [7].In the present paper we synthesized copper oxide nanoparticles by solution combustion method.

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II.Experimental Details

Synthesis of copper oxide nanoparticles by solution combustion method.

1g of copper nitrate was taken in a beaker to this 2g of glycine and 30ml of water was added then kept beaker on a hot plate upto completely charged .The solid was obtained. The obtained solid was transferred into crucible and kept it in combustion chamber maintained at 800^0C for 3hour.The coloured CuO was obtained.

III. Results and discussions

3.1 UV-visible Spectra:

The synthesized CuO nanoparticles has showed that maximum intensity peak at 297nm.The band gap of CuO nanoparticles was calculated using Tauc plot it was found to be 2.24eV [8].

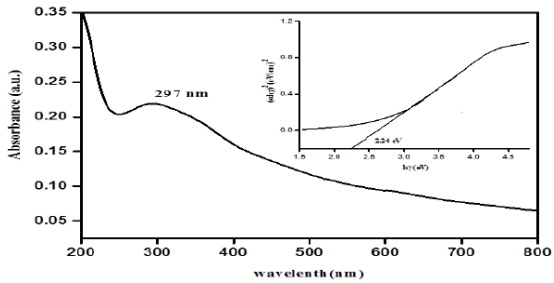

Fig. 1. UV-Visible spectra and Tauc plot of CuO nanoparticles

3.2. X-ray Diffraction

The purity of synthesized CuO nanoparticles were identified using X-ray diffraction .The position of the peak 2teta is 38.7^0, 48.6^0, 53.5^0,58.2^0,67.8^0,65.8^0.Rapidly indexed as (111) (202) (020) (113) (022) .The crystal structure was found to be Monoclinic and crystal structure was found to be 31.2nm from the XRD pattern [9].

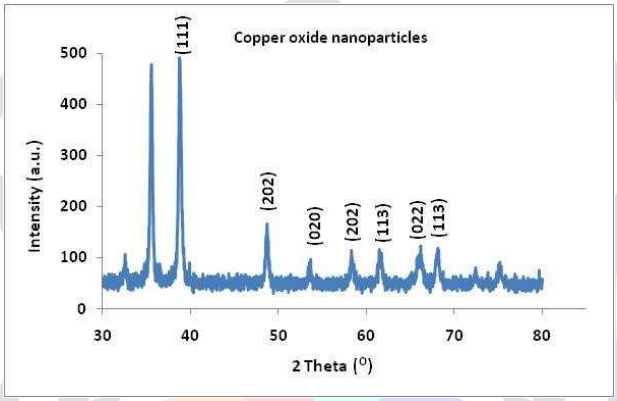

Fig. 2. X-ray diffraction spectra of CuO nanoparticles

3.3. Scanning Electron Microscopy (SEM)

The SEM image of CuO nanoparticles consists of agglomerated particles and it was observed using SEM micrographs.

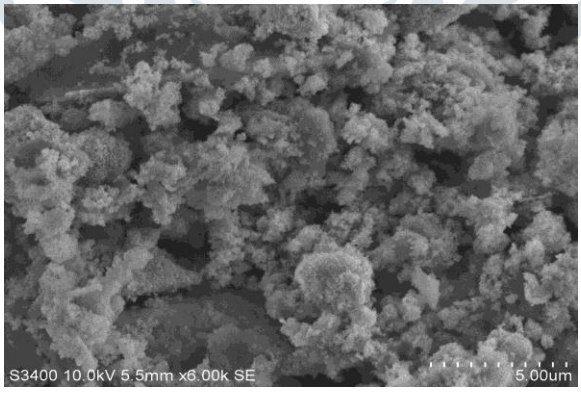

Fig 4. SEM images of synthesized CuO Nanoparticles

IV. Microorganisms

Microbial cultures were procured from Microbial Type Culture Collection (MTCC), Institute of Microbial Technology (IMTECH), Chandigarh, India. The cultures used were *Escherichia coli* (MTCC-40), *Staphylococcus aureus* (MTCC 7443), *Candida albicans* (MTCC-183) and *Aspergillus niger* (MTCC-1344). Bacterial and fungal stock cultures were maintained on nutrient agar and Potato dextrose agar slants respectively at 4 °C with periodical sub-culturing.

Antimicrobial study:

The *in-vitro* antimicrobial activity was evaluated against the *Staphylococcus aureus* (MTCC-7443) and *Escherichia coli* (MTCC-40) by disc diffusion method.[1] 100 µL of 24 hours cultures of test microorganisms in broth were used for the seeding and poured to the Petri plates and allowed to cool to room temperature, in laminar air flow. The discs were positioned on the Petri plates and added the 500 µg/mL of the test solutions to the discs. The disc with only solvent was served for the negative control and standard drug Chloramphenicol was served as positive control for comparing the activities. The plates were incubated at 37 ^{0}C temperature for 24 hours. The diameters of the zone of inhibitions (in mm) were measured after completion of the incubation.

Anti-fungal activity study:

The *in-vitro* antifungal activity was determined against *Candida albicans* (MTCC-183) and *Aspergillus niger* (MTCC-1344) by disc diffusion method. 100 µL of 24 hour culture of test microorganisms in broth was used for the seeding and poured to the Petri plates and allowed to cool in laminar air flow. The discs were positioned on the Petri plates and 500 µg/mL of the test solutions were added to the discs. The disc with only solvent acts as the negative control and standard drugs Nystatin was used as positive control for comparing the activities. The fungal plates were incubated at 30 °C temperature for five days. The diameters of the zone of inhibitions (in mm) were measured after sufficient growth of the microorganisms[10,11].

Determination of Minimum Inhibitory Concentration (MIC):

Those compounds which showed activity at 500 µg/mL, were further investigated at lower concentrations to know their minimum concentration at which compound shows the activity against the microbial strain. Here test samples were prepared by half fold dilution method over the range of 250 µg/mL, 125 µg/mL, 62.5 µg/mL to 0.9 µg/mL and their activities were measured by disc diffusion method.[2] The lower concentration of the compound to exhibit the antimicrobial activity was noted.

Antimicrobial activity of the synthesized copper oxide nanoparticles.

Compound no.	Zone of inhibition (mm) at the concentration of 500µg/mL			
	Escherichia coli	*Staphylococcus aureus*	*Candida Albicans*	*Aspergillus niger*
CuO	12	20	13	**15**
2	10	**11**	11	12
Chloramphenicol	25	19	-	-
Bavistin	-	-	15	27

Antimicrobial activity of the synthesized copper oxide nanoparticles

Compound no.	MIC (in µg/mL)			
	Escherichia coli	*Staphylococcus aureus*	*Candida Albicans*	*Aspergillus niger*
CuO	250	125	500	**250**
2	500	**250**	500	500
Chloramphen-icol	**3.125**	**50**	**-**	**-**
Bavistin	**-**	**-**	**1.56**	**0.195**

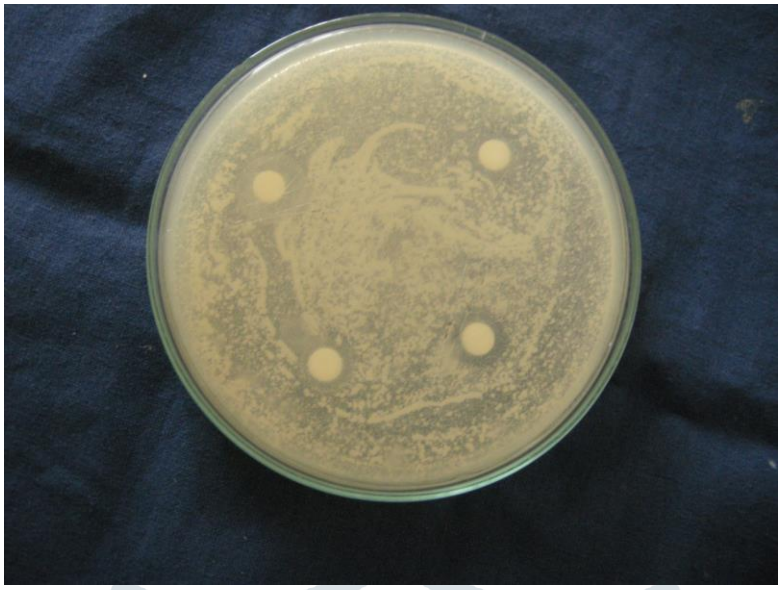

Fig.5. Appearances of inhibitory zones of CuO nanoparticles

V. Conclusion

In the present paper the CuO nanoparticles were synthesized by solution combustion method .The synthesized CuO nanoparticles were characterized by SEM, XRD, and UV analysis. The CuO nanoparticles show good inactivation of different strains of bacteria.

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