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SYNTHESIS OF MIXED METAL OXIDES AND ANTIMICROBIAL ACTIVITY WITH WATER REMEDIATION APPLICATION

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ABSTRACT:

A new oval shaped $CaTiAlO_4$ Nano particles were synthesized by wet chemical Co-precipitation and muffle ignition method. The oval shapes of Nano material were confirmed using SEM imaging and spinal packing in crystals were determined on the basis of XRD spectrum. The surface functionalities over Nano material was confirmed using FTIR spectrum elucidating hydroxyl and oxide groups over surface for future water wet ability. Furthermore the porous nature and electronic states in Nano material were elaborated on the basis of UV-Vis. and PL spectral transitions along with matching SEM and XRD data. The very high porosity of this ceramic Nano material was confirmed by BET measurements and future water remediation applications were demonstrated using antimicrobial testing on Klebsiella and membrane water purification activity. Overall this novel ceramic porous Nano material has proved probable application in water purification membranes.

KEYWORDS : *Oval ceramic, Nano material, Highly Porous, Water remediation*

INTRODUCTION

With the idea in the field of ceramic water nanotechnology, here in this research work we had developed a new class of trio oval metal oxide ceramic nanocomposite material for microbial remediation of surface water resources. Calcium and Titanium based materials are used nowadays for antimicrobial applications in various fields. [1-4] Along with sodium it can form stable mix metal oxide to result trio metal ceramic type material with good expected porosity. Porosity is mainly important for water remediation and antimicrobial effects of bacterial cell adhesion. So here this research work we had synthesized this mixed metal oxide ceramic nanocomposite for such porosity required for antimicrobial effects and future water remediation application.[5-10]

Nanotechnology have emergent research fields which are growing towards development of new class of ceramic metal oxide materials used for water remediation. Ceramic metal oxide nanoparticles and nano composites are having suitable applications for antimicrobial and cleansing of water pollutants and agents. Limited number of reports have been attempted and published by researchers in this field. So there is need of development of new class of cheaper and suitable nanocomposite mix metal oxide ceramic material to kill microbial contents of water resources to generate good quality of potable water.[11,12]

Hydrogen peroxide is the major theme for this application of ceramic nanocomposites as these materials generate peroxide entities with porous surface in water. So in continuation with these ideas we had also explained the suitable mechanism for antimicrobial activity of this ceramic material in our paper. So this Oval ceramic material can be used not only for antimicrobial application but also for water remediation.[13-18]

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EXPERIMENTAL SECTION:

Materials and cell cultures:

All the chemicals used for synthesis nano composites and their *in vitro* biological screening such as aluminum nitrate, titanium chloride, calcium nitrate, conc. HCl, ethanol were of A. R. grade. These chemicals were purchased from S. D. fine chem. ltd. and Merck ltd and were used without further purification. The cell culture medium such as agar growth broth and bacterial culture, fetal bovine serum, trypsin buffer were obtained from Hi-media ltd. The double distilled water was obtained from millipore system and used throughout the synthesis and *in vitro* biological screening tests.

Synthesis of oval ceramic nanoparticles (co-precipitation method) :

All the metal salts are mixed in 0.01M proportion in 25 ml. double distilled water and traces of HCl are added to the flask. The flask contents are vortexes on magnetic stirrer at 600 rpm. for 6 hours then visible color change was observed after formation of precipitate. The precipitate was washed with double distilled water and dried in oven at 92^{O}C. The dried trio metal oxide nano composite ceramic powder was then crushed. This powder was characterized and used for antimicrobial studies for to use in water remediation.

Synthesis $CaTiAlO_4$:

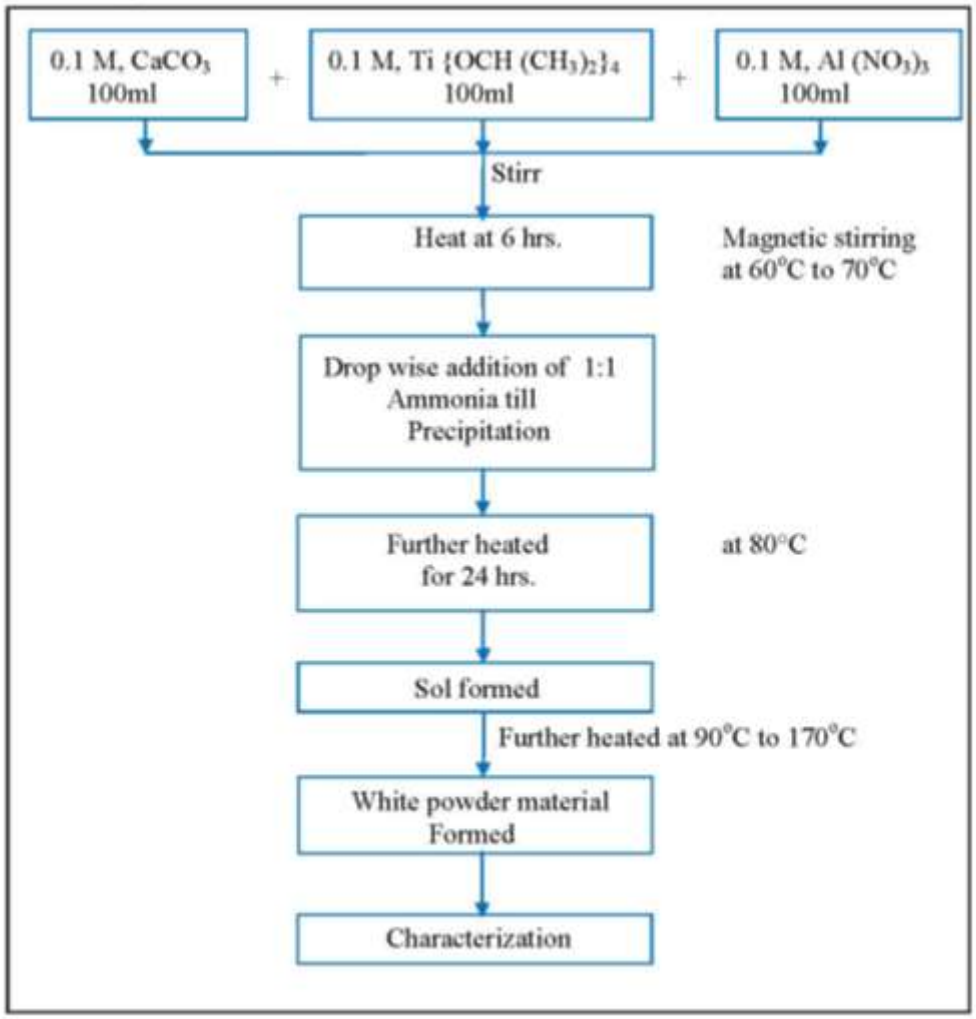

Fig. 3.3 Flow sheet diagram of $CaTiAlO_4$ nanomaterial

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ANTIMICROBIAL ACTIVITY WITH WATER REMEDIATION APPLICATION :

As per fig. and table, for antimicrobial activity of 20 ppm. material on S. Aureus it had been demonstrated that good zone of inhibition with better antimicrobial activity.

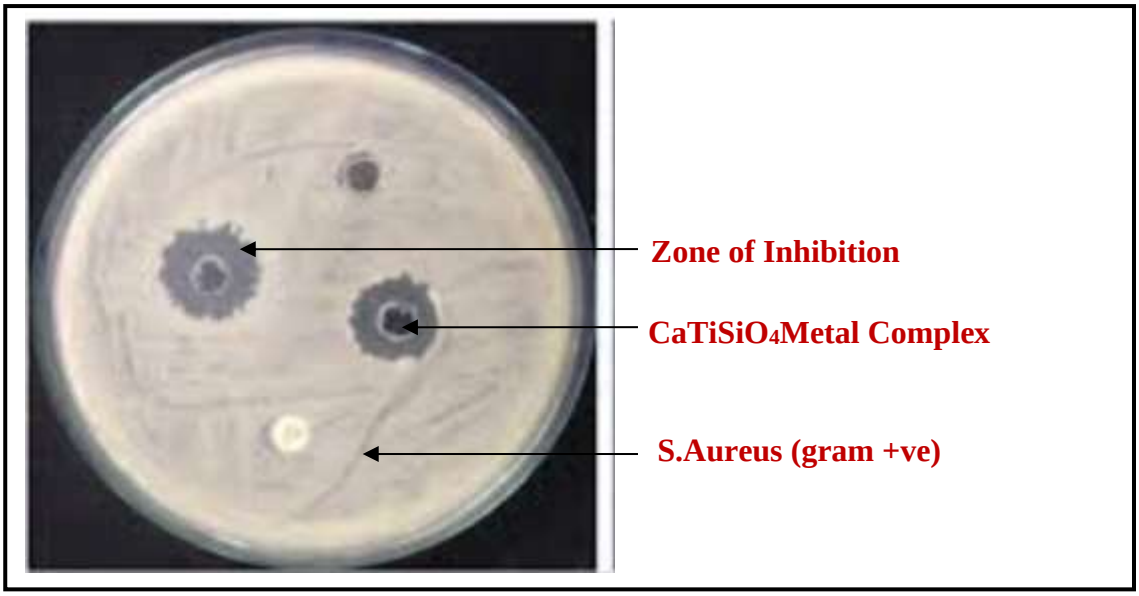

Fig. : Anti microbial effects of $CaTiAlO_4$ ceramic nanomaterial on S. Aureus for zone of inhibition at 20 ppm.

Table : Anti-microbial activities of Schiff base and complex compared for gram positive and gram negative bacteria.

Type/ name of bacterial culture in agar broth [as per figures]	Zones of inhibition for gram negative bacteria as zone diameter in mm. for concentrations of drug/ dose of ceramic nanomaterial	
	At 10 ppm.	At 25 ppm. Fig.
S. Aureus *(gram +ve)*	15 mm.	27 mm.

Mechanism for antimicrobial activity and water remediation activity :

As per physicochemical and antimicrobial screening of material and elaboration in scheme 1(page no.106), the oval nanomaterial trio metal oxide ceramic nanocomposite exhibits antimicrobial and water remediation potential at surface by material cell interactions. Here as material have surface porosity after reaction with cell membrane material and water the surface of material show adhesion to liquid and biomaterials which result in dissociation of nanocomposite to oxides on surface so result to production of peroxide on surface. This peroxide produced at surface of nanomaterial further can produce oxide and super oxide radicals to give antimicrobial effects for water remediation activity.

WATER REMEDIATION ACTIVITY OF $CaTiAlO_4$:

λ Max is 670 nm. At this λ max, methylene blue dye with concentration 20 ppm has been used. This concentration is prepared as 150mg / 100ml. It is photocatalyst amount. Sample is observed in total 180min. of an interval of 30min. PH of solution is maintained 7.4 and source of light is 365nm Hg Vapor lamp.(table)

After 180min. it has been observed that the degradation of Methylene Blue Dye rate is 68% indicates that this metal complex is very effective for water remedial activity.(Table)

Scheme 1

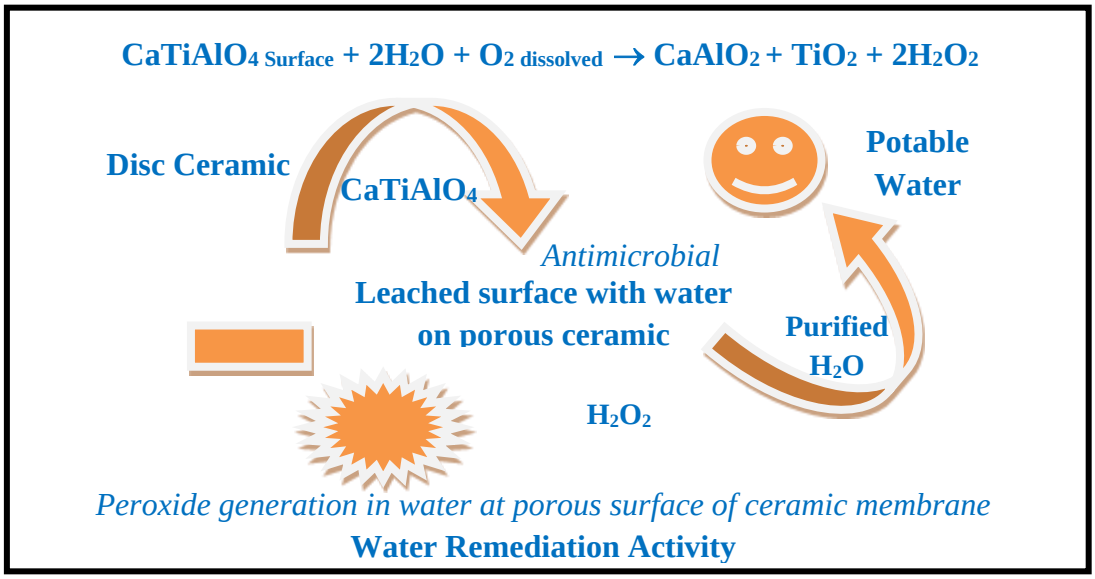

Table : Degradation Parameters

1.	Dye	Methylene blue dye
2.	Concentration	20 ppm
3.	Photocatalyst's amount	150mg/100mL
4.	Degradation Time	180 min
5.	Degradation Efficiency	68%
6.	pH	7.4
7.	Source of light	365 nm Hg Vapor lamp

Table : Percentage degradation during course of time

Time	**% degradation of MB**
Blank	00
Adsorption	5
30 min	19
60 min	33
90 min	42
120 min	66
150 min	67
180 min	68

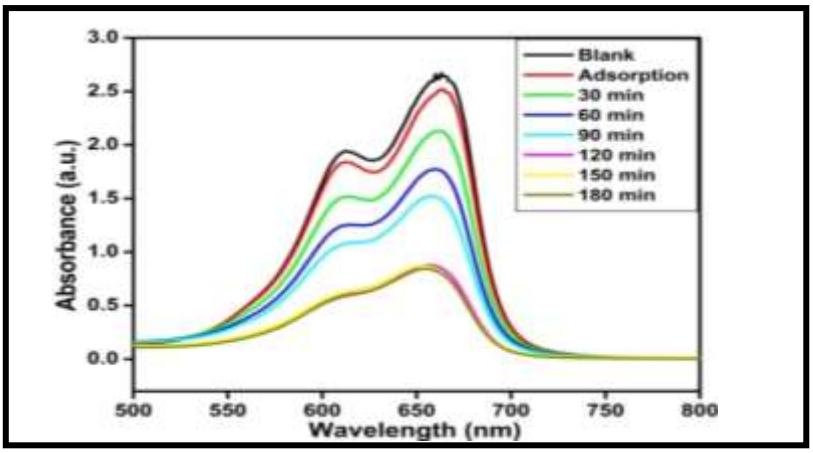

Fig.: Absorbance

In testing of water remedial activity of our ceramic composite nanomaterial $CaTiAlO_4$with methylene blue dye, the maximum band gap is 3.63 ev and it has been observed that maximum absorption is at 650nm at 180 min. indicates that colour of methylene blue dye disappears. This nano composite material $CaTiAlO_4$ shows good water remedial activity.

CONCLUSIONS :

A new oval shaped trio metal oxide based ceramic nano material was prepared by using simple wet chemical and drying route. This nano material with 55 nm. mean size had exhibited surface porosity on the basis of BET isotherm N_2 adsorption. The absorption and emission spectra of nano material had proved presence oxide free electrons on surface. The nano material possesses surface oxide and hydroxide species for water loving nature of material on the basis of FTIR analysis. Hence these evidences for nano material had elaborated its properties for antimicrobial water remediation potential. On the basis of antimicrobial testing of the material it has been determined that this oval ceramic trio metal oxide nano material finds applications in water purification and environmental fields.

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