SYNTHESIS OF GREEN CATALYST BY $AlCaSi_5O_{15}$ FOR WATER REMEDICATION ACTIVITY

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ABSTRACT:

A new oval shaped $AlCaSi_5O_{15}$ 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

Ceramic metal oxide nanoparticles have suitable application for anti-microbial and water remediation with the idea in the field of ceramic nanotechnology. In this research work, new class of trio metal oxide ceramic nano composite material was prepared. $AlCaSi_5O_{15}$, this nano composite material has good anti-microbial activity and good water remediation property.[1-2] Calcium and aluminium based materials are used for antimicrobial applications in various fields along with silicate. It can form stable mixed metal oxide, trio metal ceramic type material. This material has good porosity. It is useful for water remediation and antimicrobial effects of bacterial cell wall. Hydrogen peroxide is the major material for the application of ceramic nano composite material. This nano composite material develops peroxide entities with porous surface of water. Hence this material is applicable for antimicrobial activity and water remediation.

Silicate oxide is a very good material used for preparation of ceramic membranes. It is also called silica or kalii bromidum or silicic oxide. It is widely found in nature as quartz. In the present era of scarcity of water resources, effective treatment of wastewater is a major prerequisite for growing economy. It is critical to develop and implement advanced wastewater treatment technologies with high efficiency and low capital requirement. Among various treatments, recent advanced processes in nano-material sciences have been attracting the attention of scientists. The nano-adsorbents such as activated carbon, carbon nanotubes, grapheme, titanium oxide, magnesium oxide and ferric oxide are usually applied for removal of heavy metals from the wastewater. Also nano-catalysts such as photocatalyst, electrocatalyst, fenton based catalyst, and chemical oxidant has been shown the potential for removing both organic and inorganic contaminants.[3-4] Currently, the research is more focused towards nano structured catalyst

with enhanced physiochemical properties. Nanoscale catalysts have high specific surface area and surface energy, which ultimately lead to the high catalytic activity. Nano-catalysts improve the selectivity of the reactions at a lower temperature, reducing the occurrence of side reactions, higher recycling rates and recovery of energy consumption. Therefore, these are widely used in green chemistry, environmental remediation, and efficient conversion of biomass, renewable energy development and other areas of interest.[5-6]

The advantage of silica ceramic membrane with calcium and aluminum metal oxide is to provide production of $AlCaSi_5O_{15}$. This ceramic membrane has small particle size.[7-9] This new ceramic nano composite material is suitable for water purification and oxidation of pollutants and activation of H_2O_2. The porosity of this ceramic nano-material was confirmed by BET measurement and further water remedial applications were demonstrated by using anti-microbial testing on Salmonella Typhe. Salmonella is a genus of rod-shaped (bacillus) Gram-negative bacteria of the family Enterobacteriaceae. The two species of salmonella are Salmonella enteric and Salmonella bongori. Salmonella was named after Daniel Elmer Salmon, an American veterinary surgeon. Typhoid fever, also known simply as typhoid is a bacterial infection due to a specific type of salmonella that causes symptoms, like fever, weakness, abdominal pain, headache, constipation and mild vomiting. This newly synthesized nano- composite ceramic material creates zone of inhibition for Salmonella Typhe, indicates that this ceramic material kills such type of water born microorganism. Thus it is applicable in water purification as green catalyst.[11,19]

Synthesis : $AlCaSi_5O_{15}$

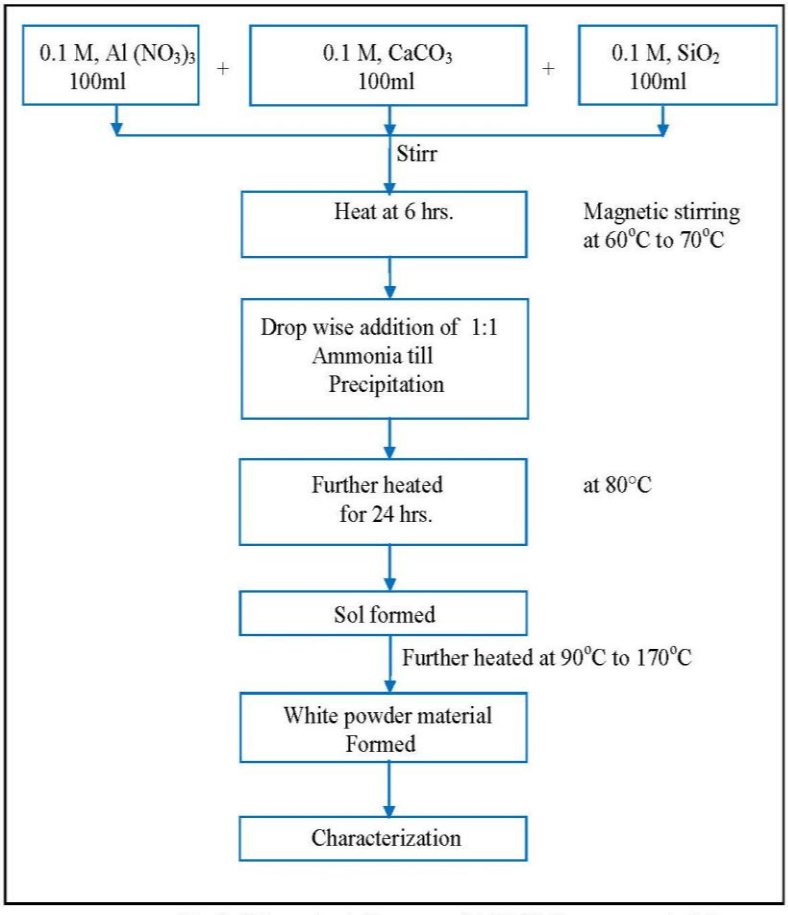

Fig.3.4 Flow sheet diagram of $AlCaSi_5O_{15}$ nanomaterial

WATER REMEDIATION ACTIVITY

Antimicrobial properties for water remediation of nanomaterial :

As per Fig. 6.7 and Table 6.3, for antimicrobial activity of 26 ppm. material on *Salmonella*, it had been demonstrated that good zone of inhibition with better antimicrobial activity.

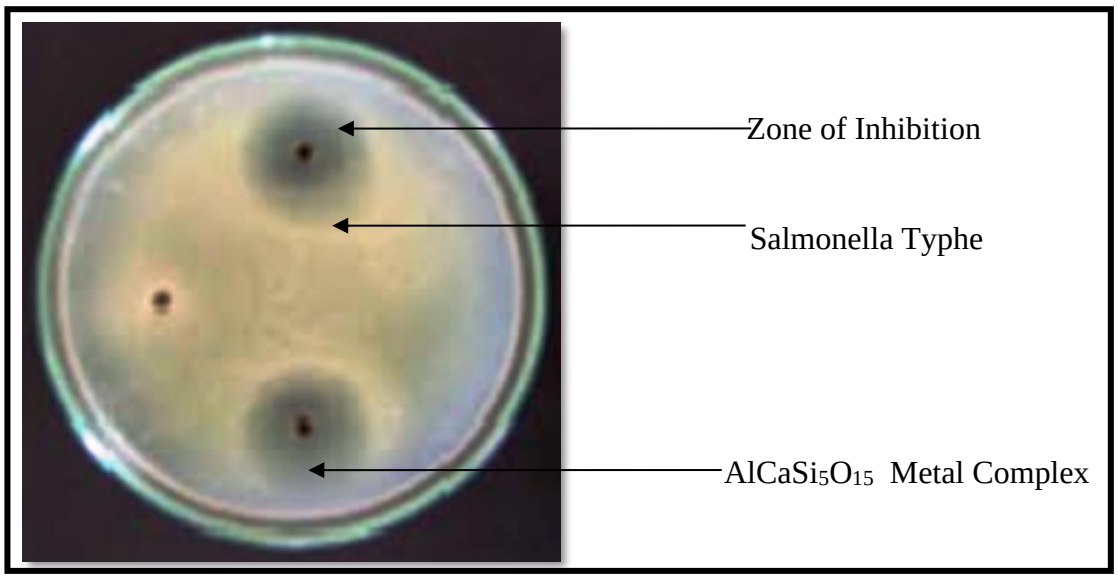

Fig. : Anti microbial effects of ceramic nanomaterial on Salmonella for zone of inhibition at 26 ppm.

Table 3: 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.
Salmonella (gram -ve)	14 mm.	26 mm.

Mechanism for antimicrobial activity and water remediation activity:

As per physicochemical and antimicrobial screening of material and elaboration in scheme 1(page no.120), the disc 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.[12,13]

Water Remediation Activity of $AlCaSi_5O_{15}$:

λ max is 670nm**.** At this λ max methylene blue dye with concentration 26 ppm has been used. This concentration is prepared as 150 mg 100 ml. It is photocatalyst amount. Sample is observed in total 150 min. of an interval of 30 minutes. PH of solution is maintained 7.8 and source of light is 365 nm Hg vapour lamp.

After 150 min it has been observed that the degradation of methylene blue dye rate is 97%, indicates that this metal complex is very effective for water remedial activity. Hence this nano material acts as a good green catalyst.[11,20]

In the mechanism of water remediation, it has been observed that mixed metal oxide acts as a catalyst. This mixed metal oxide reacts with methylene blue dye with living behind H_2O_2. This H_2O_2 acts as a strong oxidizing agent known as peroxide generation which disintegrates the activity of microorganisms. Thus, it disappears the colour of methylene blue in 180 min. The percentage degradation is 97%. The water free from methylene blue indicator acts as a potable water.

Scheme 1

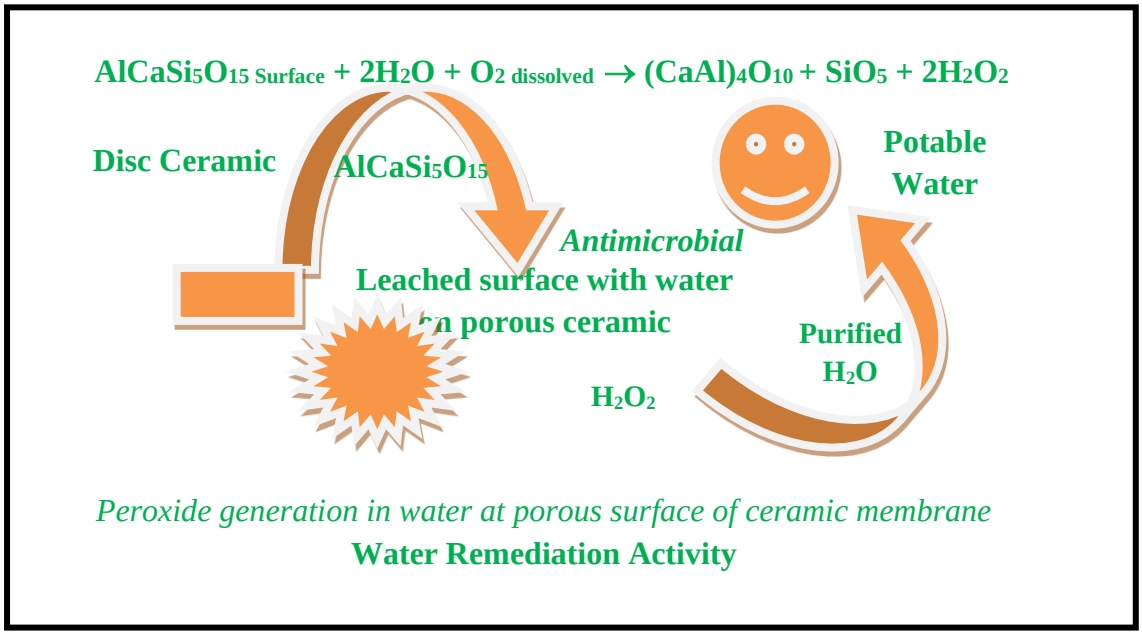

Table : Degradation Parameters

1.	Dye	Methylene blue dye
2.	Concentration	26 ppm
3.	Photocatalyst's amount	150mg/100mL
4.	Degradation Time	150 min
5.	Degradation Efficiency	97%
6.	pH	7.8
7.	Source of light	365 nm Hg Vapor lamp

Table : Percentage degradation during course of time

Time	**% Degradation of MB**
Blank	00
Adsorption	0.45
30 min	40
60 min	67
90 min	84
120 min	93
150 min	97

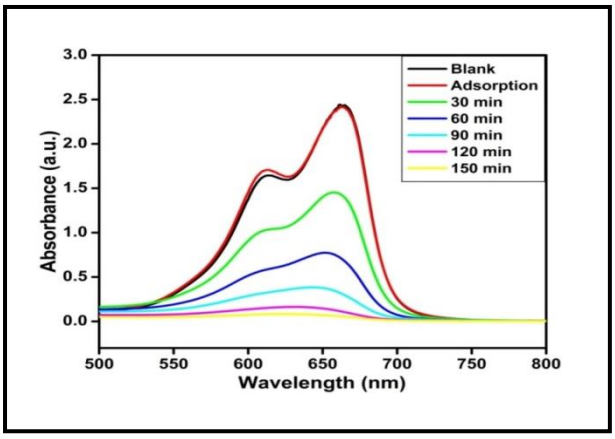

Fig. : Absorbance Spectrum

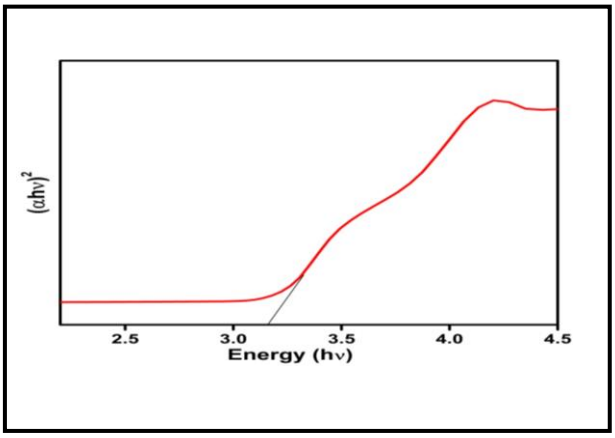

Fig. : Band Gap – 3.15 eV

In testing of water remedial activity of our ceramic composite nanomaterial $AlCaSi_5O_{15}$ with methylene blue dye, the maximum bandgap is 3.15 ev and it has been observed that maximum absorption is at 650nm at 150 min. indicates that colour of methylene blue dye disappears. Our nano composite material $AlCaSi_5O_{15}$ shows good water remedial activity.

CONCLUSIONS

A new oval shaped trio metal oxide based ceramic nano material was prepared using simple wet chemical and drying route. This nano material of 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 posses 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 % Degradation of Methylene blue is 97% indicate that, this oval ceramic trio metal oxide nanomaterial finds applications in water purification and environmental fields and also acts as a good green catalyst.

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