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Synthesis of Ceramic Membrane and its Biological Applications

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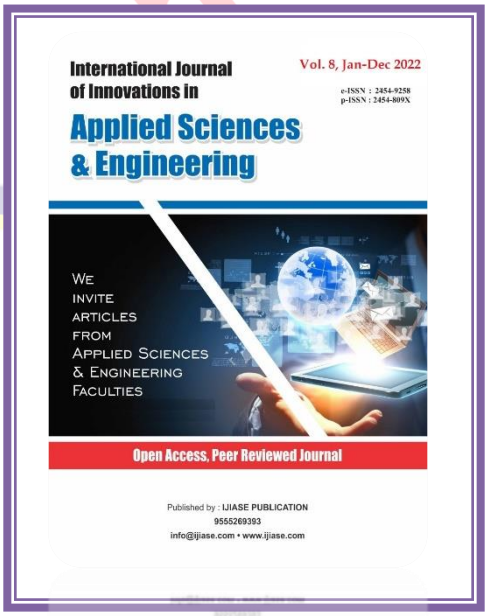


ABSTRACT

A new oval shaped CaTiSiO5 and AlTiZrO4 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 were 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

Synthesis of ceramic membrane :

Since the last two decades, synthesis method of nano structured materials, synthesis for required shaped nano material with the best and correct dimension is important for understanding the structure and composition of the materials. For the synthesis of controlled size shaped nano materials and required to ceramic membrane and its application.

Synthesis of $CaTiSiO_5$ disc nanoparticles (Co-Precipitation Method) :

All metal salts are mixed in 0.1M proportion in 100ml double distilled water and the flask on magnetic stirrer at 600 rpm for 6 hours at 60°C and continue added drops wise ammonia (200ml) solution. This solution stirs 14 hrs. at 60° – 70°C, then precipitate is over dry at 50°C, then white powder is formed.

Synthesis of $AlTiZrO_4$ (Co-Precipitation Method) :

All metal salts are mixed in 0.1M proportion in 100ml double distilled water and the flask on magnetic stirrer at 600 rpm for 6 hrs. at 60°C and continue added drops wise (200ml) ammonia solution. This mixture stirs 14 hrs. at 60°–70°C formed precipitate are over dry at 50°C then white powder is formed used this by characterization.

Synthesis of $CaTiSiO_5$:

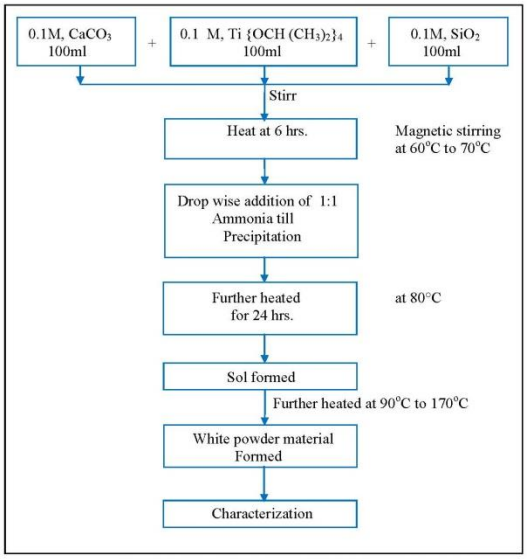


Fig.3.1 Flow sheet diagram of $CaTiSiO_5$ nanomaterial

Synthesis of $AlTiZrO_4$:

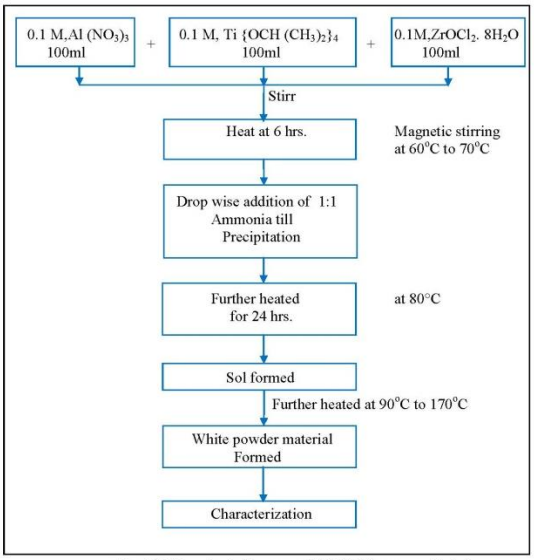
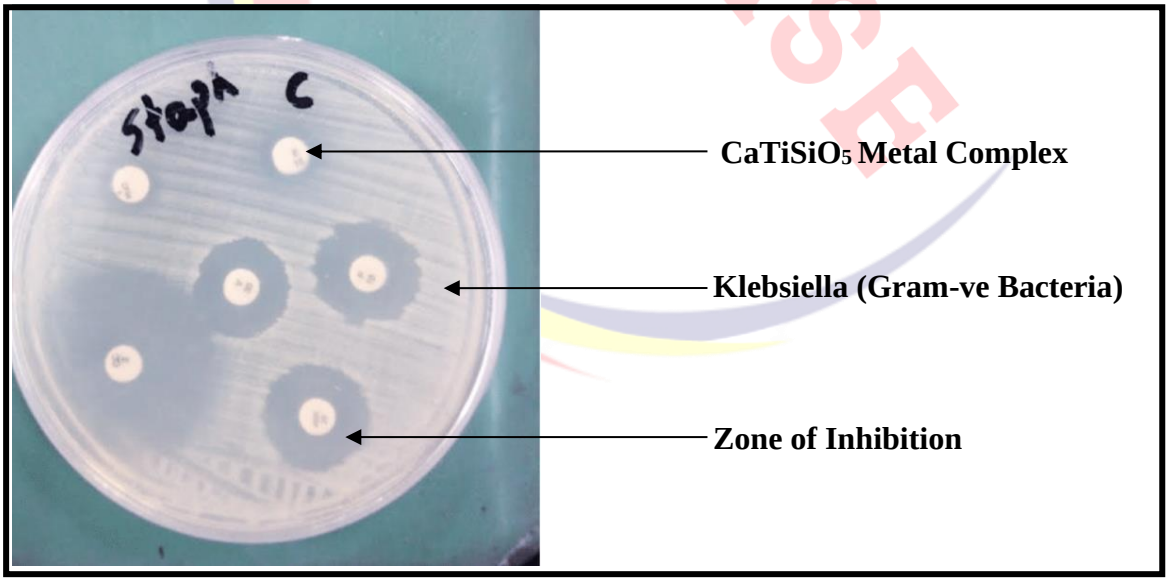


Fig. 3.2 Flow sheet diagram of $AlTiZrO_4$ nanomaterial

BIOLOGICAL APPLICATIONS :

Antimicrobial properties for water remediation of nanomaterial :

For antimicrobial activity of 24 ppm. material on Klebsiella. It had been demonstrated that good zone of inhibition with better antimicrobial activity.[9]



Anti microbial effects of ceramic nanomaterial on Klebsiella for zone of inhibition at 24 pp

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 24 ppm.
Klebsiella *(gram -ve)*	12 mm.	25 mm.

Mechanism for antimicrobial activity and water remediation activity:

As per physicochemical and antimicrobial screening of material and elaboration in scheme 1(page no.134), the disc nano material trio metal oxide ceramic nano composite exhibit 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 nano composite to oxides on surface so result to production of peroxide on surface. This peroxide produced at surface of nano material further can produce oxide and super oxide radicals to give antimicrobial effects for water remediation activity.[8-9]

Water Remediation Activity of $CaTiSiO_5$:

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 was observed in total 180min. of an interval of 30min. PH of solution is maintained 7.2 and source of light is 365nm Hg Vapor lamp.

After 180min. it has been observed that the degradation of methylene blue dye rate is 94% indicates that this metal complex is very effective for water remedial activity.[9]

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%.

Scheme 1

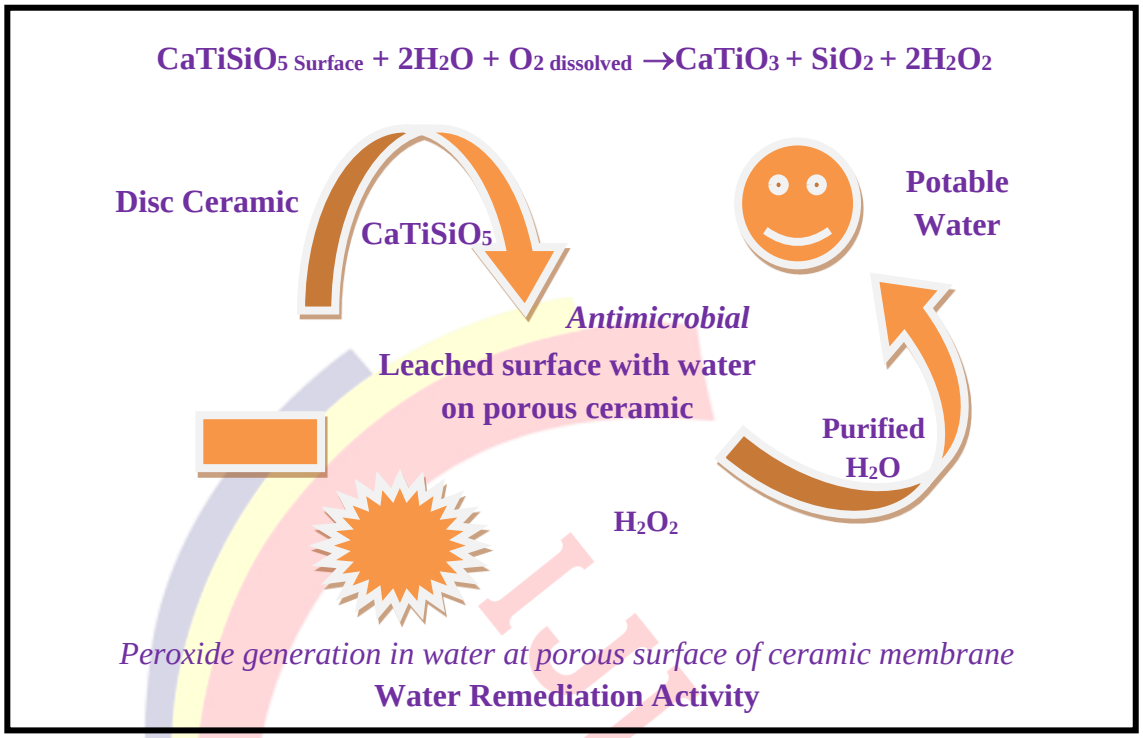
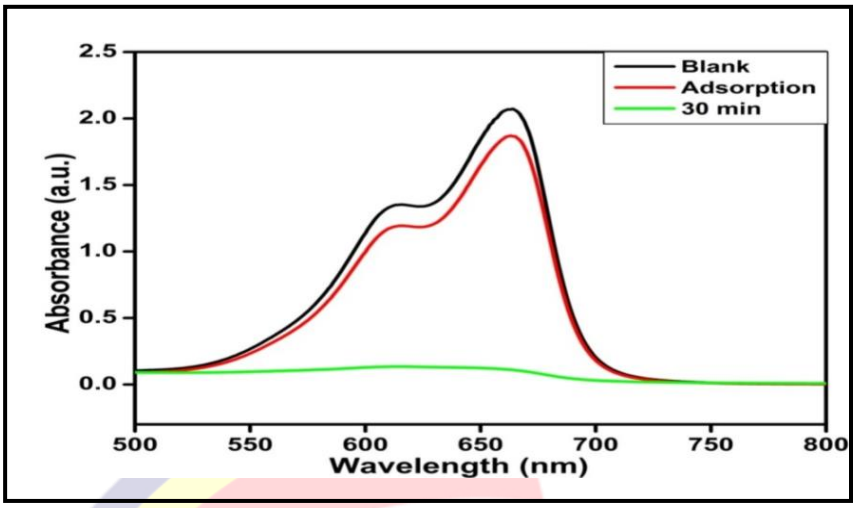


Table : Degradation Parameters

1.	Dye	Methylene blue dye
2.	Concentration	20 ppm
3.	Photocatalyst's amount	150mg/100mL
4.	Degradation Time	180 min
5.	Degradation Efficiency	94%
6.	pH	7.2
7.	Source of light	365 nm Hg Vapor lamp

Table : Percentage degradation during course of time

Time	**% degradation**
Blank	00
Adsorption	10
30 min	18
60	32
90	48
180	94



Absorption Spectrum

In testing of water remedial activity of our ceramic composite nanomaterial $CaTiSiO_5$ with methylene blue dye, the maximum bandgap is 3.20 ev and it has been observed that maximum absortion is at 650nm at 180 min. indicates that colour of methylene blue dye disappears. Our nano composite material $CaTiSiO_5$ shows good water remedial activity.

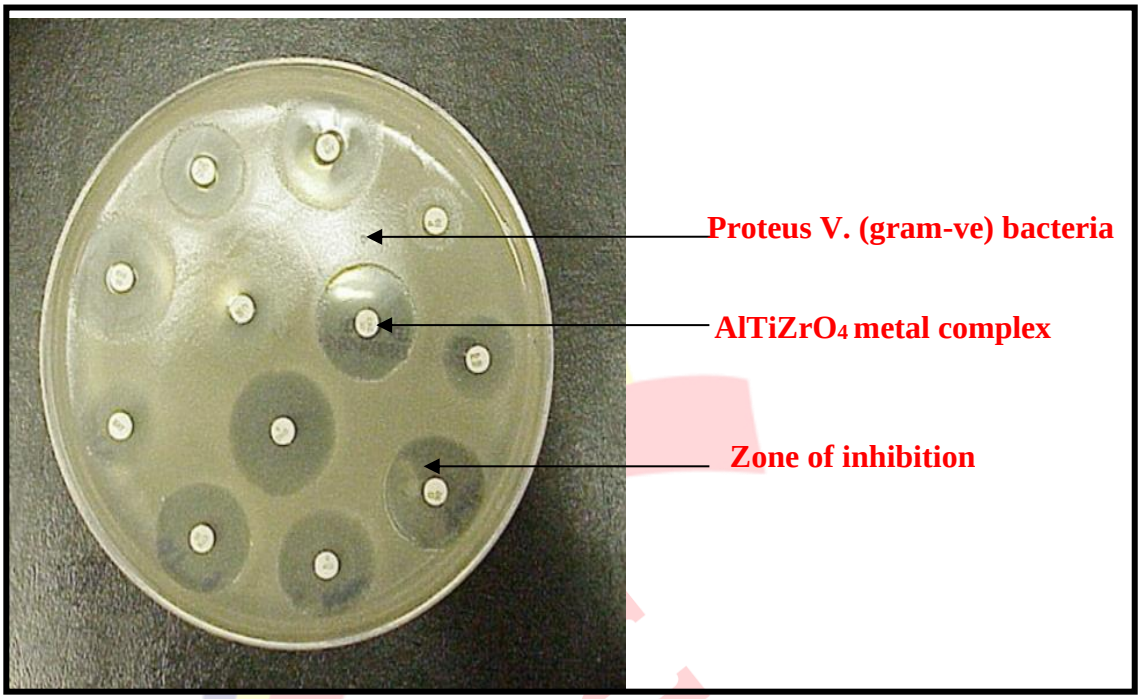
Conclusions:

A new oval shaped trio metal oxide based ceramic nanomaterial was prepared using simple wet chemical and drying route. This nanomaterial of mean size had exhibited surface porosity on the basis of BET isotherm N_2 adsorption. The absorption and emission spectra of nanomaterial had proved presence oxide free electrons on surface. The nanomaterial possess surface oxide and hydroxide species for water loving nature of material on the basis of FTIR analysis. Hence these evidences for nanomaterial 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 nanomaterial finds applications in water purification and environmental fields.

AlT_4ZrO_4 –

Antimicrobial properties for water remediation of nanomaterial :

As per figure 8.7 and table 8.4, for antimicrobial activity of 20 ppm. material on Proteus Vulgaris. It had been demonstrated that good zone of inhibition with better antimicrobial activity.



Anti microbial effects of $AlTiZrO_4$ ceramic nanomaterial on Proteus V. 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.
Proteus V. *(gram -ve)*	13 mm.	25 mm.

Mechanism for antimicrobial activity and water remediation activity :

As per physicochemical and antimicrobial screening of material and elaboration in scheme 1(page no.147), the disc nanomaterial trio metal oxide ceramic nanocomposite exhibit 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.

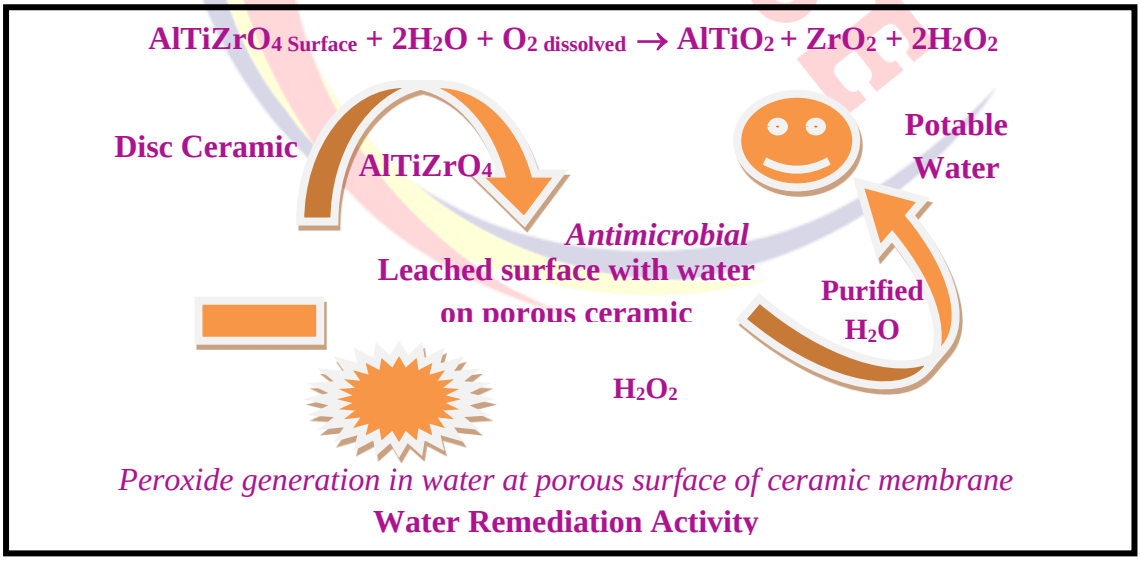
Water Remediation Activity of AlTiZrO4:

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 7.7 and source of light is 365nm Hg Vapor lamp.

After 180min. it has been observed that the degradation of mithylene blue dye rate is 82% indicates that this metal complex is very effective for water remedial activity.

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



Peroxide generation in water at porous surface of ceramic membrane

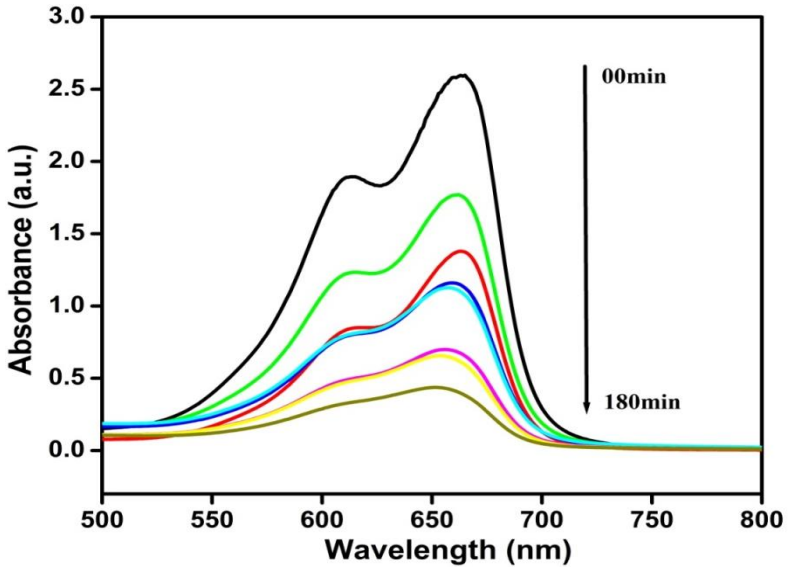
Water Remediation Activity

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	82%
6.	pH	7.7
6.	Source of light	365 nm Hg Vapor lamp

Table : Percentage degradation during course of time

Time	**% Degradation of MB**
Blank	00
Adsorption	32
30 min	47
60 min	55
90 min	58
120 min	70
150 min	76
180 min	82



Absorbance

In testing of water remedial activity of our ceramic composite nanomaterial $AlTiZrO_4$ with methylene blue dye, the maximum bandgap is 3.14 ev and it has been observed that maximum absorption is at 650nm at 180 min. indicates that colour of Mithylene blue dye disappears. Our nano composite material $AlTiZrO_4$ shows good water remedial activity

CONCLUSION:

A new oval shaped trio metal oxide based ceramic nanomaterial was prepared using simple wet chemical and drying route. This nanomaterial with 55 nm. mean size had exhibited surface porosity on the basis of BET isotherm N_2 adsorption. The absorption and emission spectra of nanomaterial had proved presence oxide free electrons on surface. The nanomaterial posses surface oxide and hydroxide species for water loving nature of material on the basis of FTIR analysis. Hence these evidences for nanomaterial 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 nanomaterial finds applications in water purification and environmental fields.

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