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# Comparative Study Of Titanium Dioxide And Lysozyme-Added Titanium Dioxide Nanoparticles For Enhanced Photocatalytic Degradation

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## INTRODUCTION & AIM

**Titanium dioxide** is a semiconductor which posses high surface area, chemical stability and photocatalytic activity, making valuable in various applications such as solar cells, water purification, and self cleaning services.

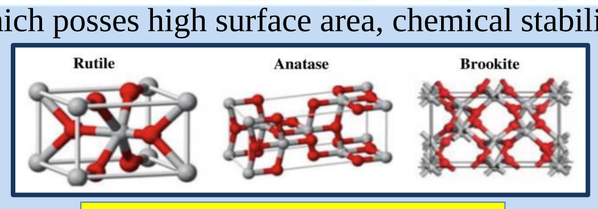


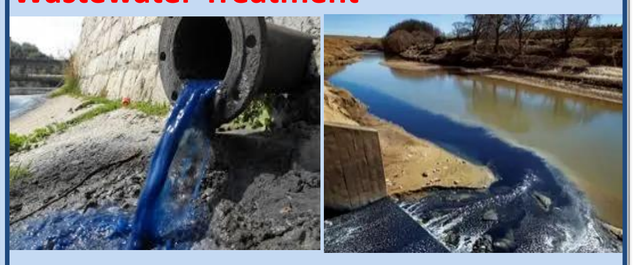

Fig 1: Crystal structures of $TiO_2$

**Lysozyme** ia a model enzyme that serves to prevent agglomeration during nanoparticle synthesis, facilitating particle size reduction and thereby enhancing photocatalytic process.

**Why hydrothermal method**

- Controlled growth and crystallinity
- Versatility and broad applicability
- Homogeneous precipitation and uniform particle size
- Energy-efficient and environment friendly

**Wastewater Treatment**



## METHOD

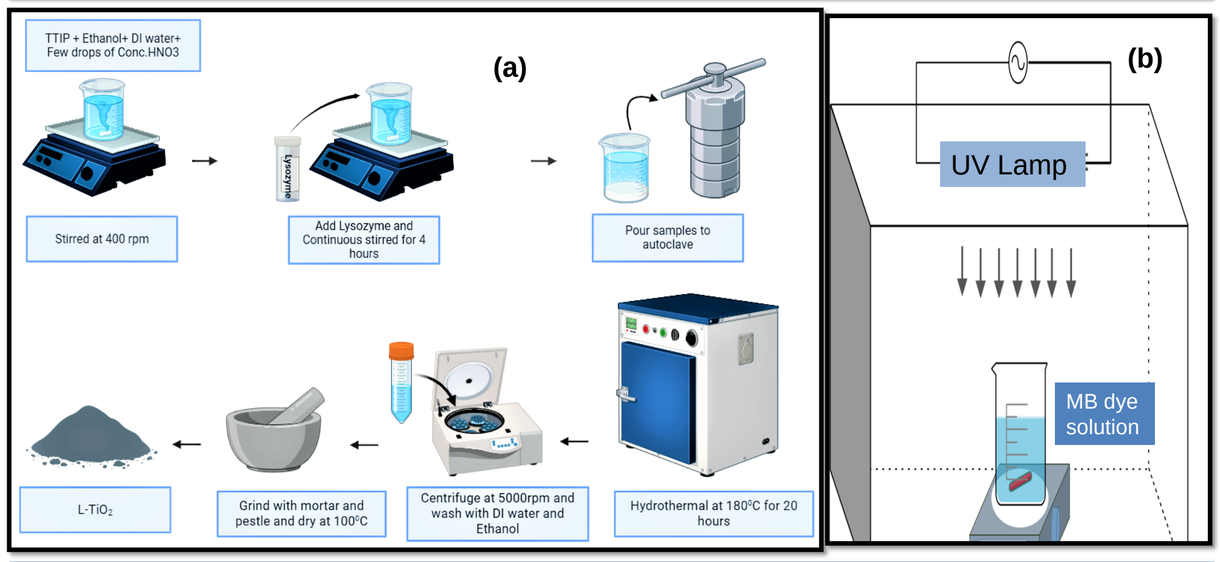



Fig 2 (a): Experimental diagram for synthesis of $TiO_2$/L-$TiO_2$ (b) Photocatalytic Setup

## CHARACTERIZATION

### X-ray Diffraction

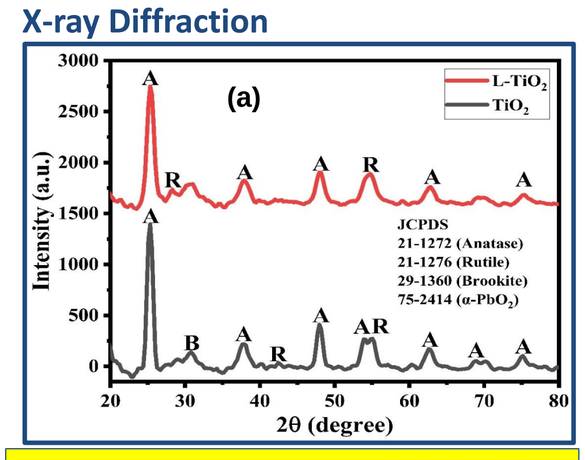



Fig 3 (a): Crystal structures of $TiO_2$/L-$TiO_2$

### FTIR spectra

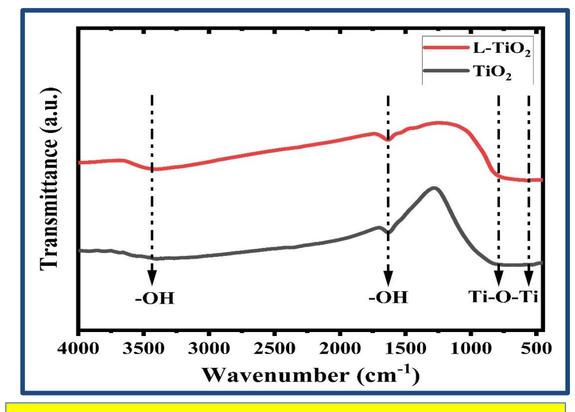



Fig 4: FTIR spectra of $TiO_2$/L-$TiO_2$

**Debye Scherer's relation**

$$D = \frac{(0.9\lambda)}{\beta \cos\theta}$$

D= crystallite size
K= scherrer's constant
λ= wavelength of X-ray radiation
β= full width at half maximum
θ= diffracting angle.

| Nanoparticles | Size (nm) |
|---|---|
| $TiO_2$ | 21 |
| L-$TiO_2$ | 12 |

Table 1: Calculated crystallite size

### FE-SEM/EDS

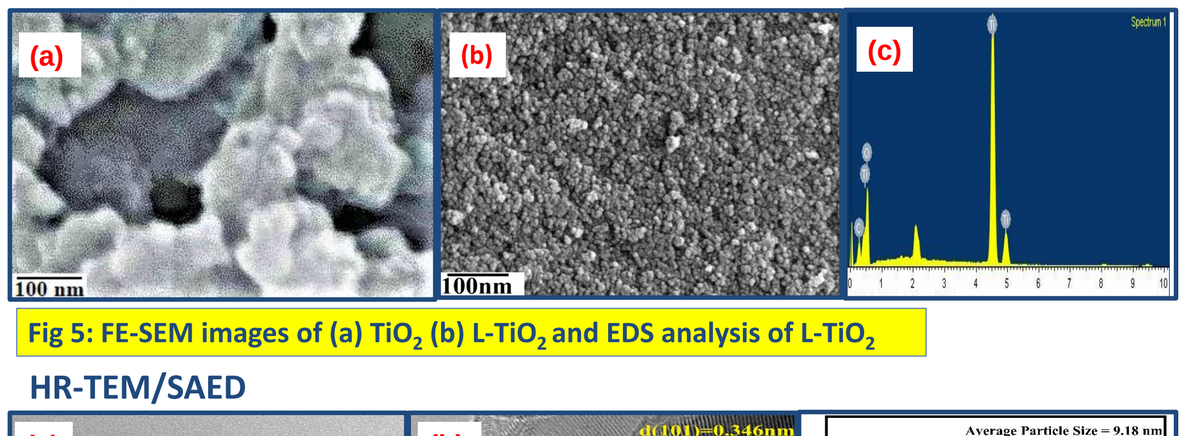



Fig 5: FE-SEM images of (a) $TiO_2$ (b) L-$TiO_2$ and EDS analysis of L-$TiO_2$

### HR-TEM/SAED

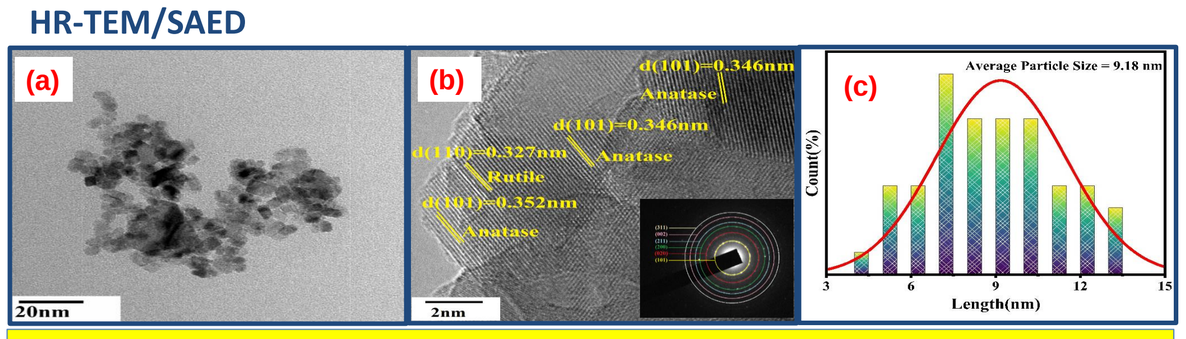



Fig 6: HR-TEM analysis of L-$TiO_2$ at (a) 20 nm (b) 2nm and (c) Histogram plot of L-$TiO_2$

## RESULTS & DISCUSSION

### 1. Band gap energy

$$(\alpha h\upsilon)^{\frac{1}{n}} = A(h\upsilon - E_g)$$

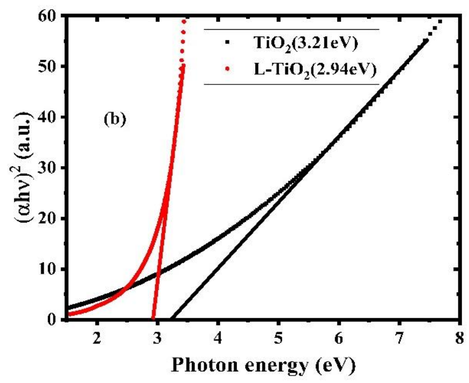



Fig 7: Band gap measurement

### Mechanism

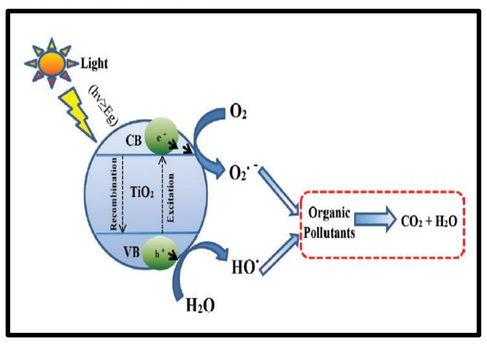



Fig 9: Mechanism of Photocatalytic degradation of dyes in UV light Irradiation

### 2. Photocatalytic activity

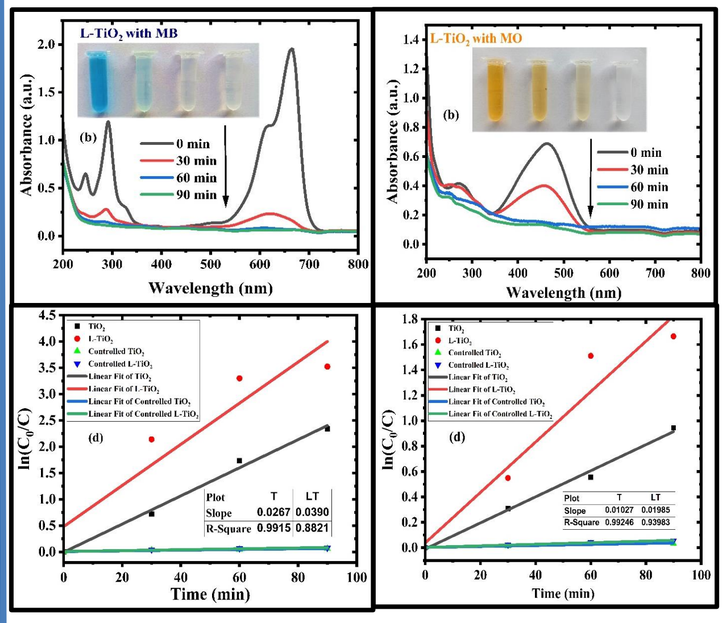



Fig 8: Degradation of MB and MO using L-$TiO_2$

| Dyes | Rate Constant $(min)^{-1}$ |
|---|---|
| Methylene Blue | |
| $TiO_2$ | 0.026 |
| L-$TiO_2$ | 0.039 |
| Methyl Orange | |
| $TiO_2$ | 0.010 |
| L-$TiO_2$ | 0.019 |

Table 2: Rate constants for MB and MO

**Pseudo first order kinetics**

$$\ln\left(\frac{Co}{C}\right) = K_{app}.t$$

$C_o$= initial concentration
C= concentration at time (t)
$K_{app}$= apparent constant in $min^{-1}$

## CONCLUSION

- Lysozyme added $TiO_2$ showed enhancing photocatalysis degrading both MB and MO under UV-light irriadiation than convensional $TiO_2$.
- HR-TEM analysis signifizes decreased in nanoparticle size from 24 nm to 9 nm upon adding Lysozyme, consistent with XRD result.
- FTIR study showed existence of chemical bonding of Ti and O.
- Both nanoparticles exhibit optimal effectiveness on 0.1 g dosage, enhancing practically and efficiently in applications.

## FUTURE WORK

- Explore application of synthesized nanoparticles in agriculture and soil remediation and crop production, aiming to mitigate pesticides contamination and enhance nutrient intake.
- Explore nanoparticles into air purification, ultimately enhancing air quality and reducing health risk.

**References**

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