Microwave plasma assisted sol-gel synthesis and plasma jet driven photocatalytic activity of TiO_2 for degradation of methylene blue

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RESEARCH BACKGROUND

- ✓ TiO_2 is a photocatalytic material used in fabrication of highly efficient photo-nano devices and degradation of organic pollutants. Different phases of TiO_2 photocatalyst are being produced through conventional physical, chemical and thermal routes. These synthesis routes also add some impurities in the product, which limit with high-tech applications.
- ✓ The plasma assisted sol-gel method is the cleanest method of synthesis of impurity free nanomaterials.
- ✓ The plasma generated UV-visible radiation can also be used to activate the photocatalyst for cost-effective and environmental friendly degradation of organic pollutant.

RESEARCH OBJECTIVES

- ✓ To synthesize TiO_2 nanoparticles through a sol-gel technique and to remove the dried gel, oxides and other impurities from the nanoparticles through microwave plasma exposure.
- ✓ The effect of plasma treatment on surface morphology, optical properties and size of the nanoparticles is also investigated in this work.
- ✓ The fully characterized nanoparticles are used for degradation of methylene blue under the exposure of argon plasma jet.

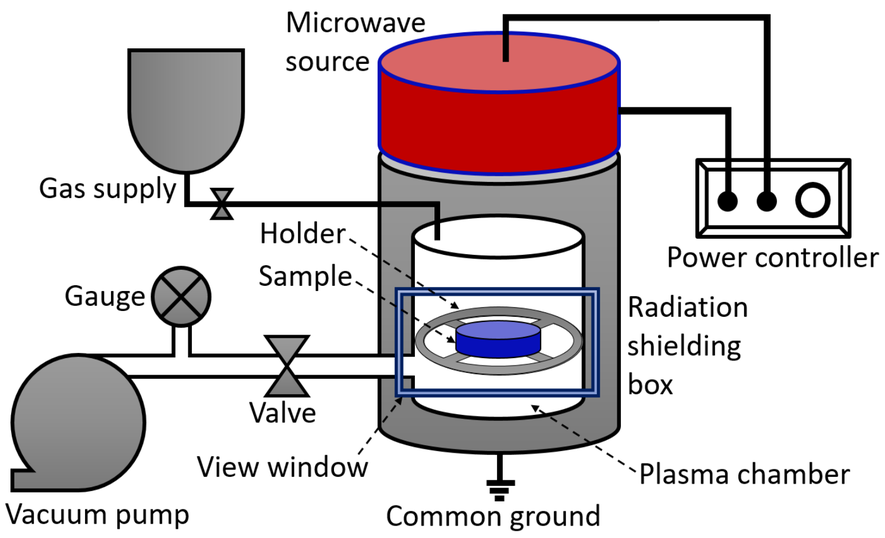
PROBLEM STATEMENT

- ✓ The available methods of synthesis of nanomaterials are energy intensive and did not provide control over the opto-physical and chemical properties of the nanomaterials.
- ✓ It is difficult to alter the post-synthesis band gap energy of the nanomaterials, especially for photocatalytic applications.

NOVELTY

A novel microwave plasma assisted sol-gel method was tested for synthesis and altering the band gap energy of TiO_2 photocatalyst for degradation of synthetic dyes under exposure of plasma generated UV-radiations. Both synthesis and dye degradation was carried out under the plasma exposure, which have never been reported in the published work.

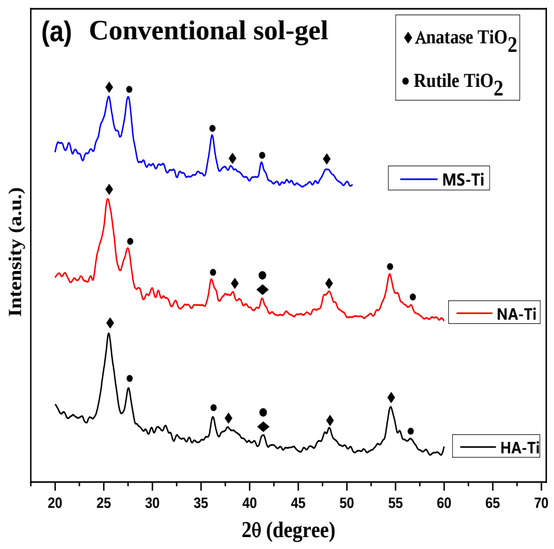
MATERIALS AND METHODS

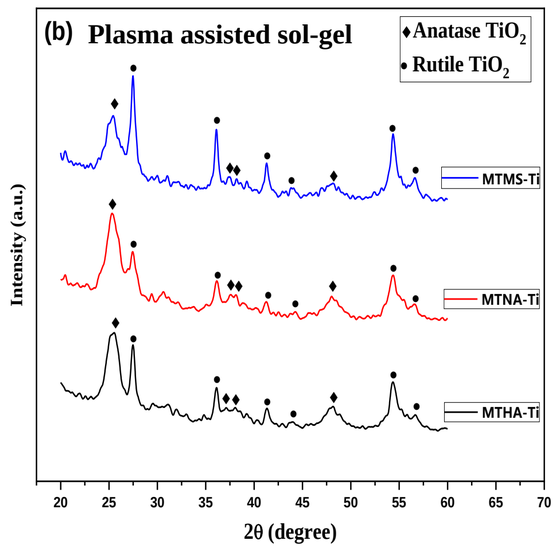


Schematic of microwave plasma assisted sol-gel synthesis method adopted for production of TiO_2 nanoparticles.

Schematic of photocatalytic degradation of methylene blue dye using TiO_2 catalyst under DC plasma jet exposure.

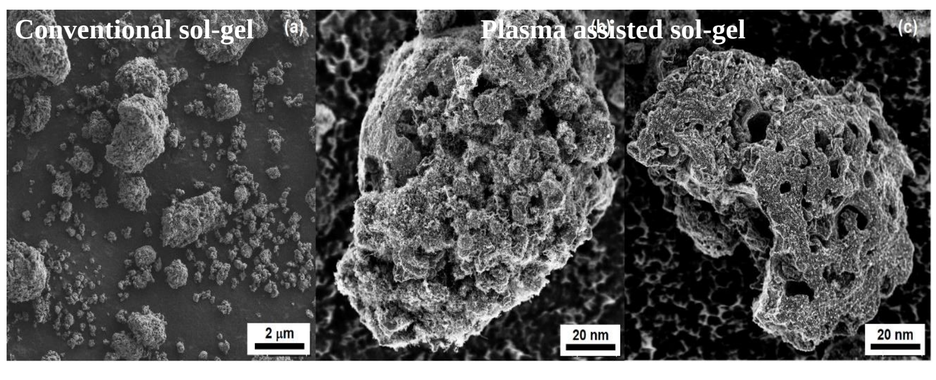
RESULTS AND DISCUSSION

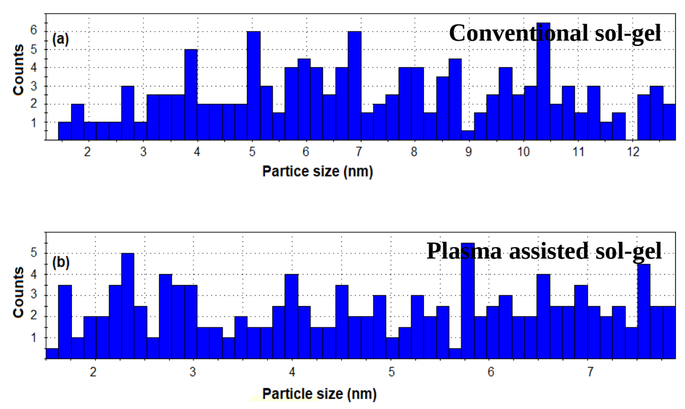


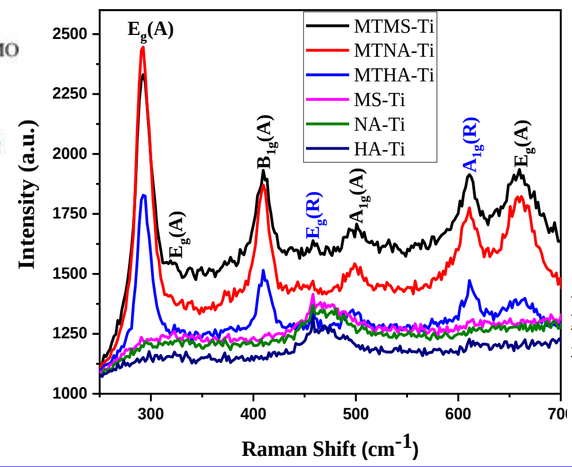


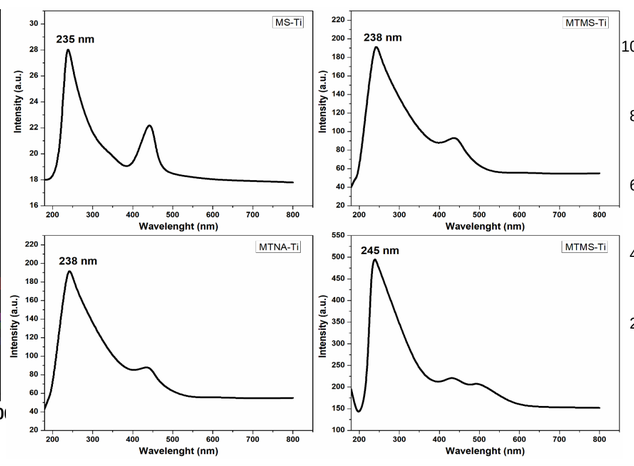
Sample	Plasma exposure	Average crystallite size (nm)
HA-Ti	No	8.1
NA-Ti	No	7.4
MS-Ti	No	8.5
MTHA-Ti	Yes	6.4
MTNA-Ti	Yes	5.2
MTMS-Ti	Yes	6.4

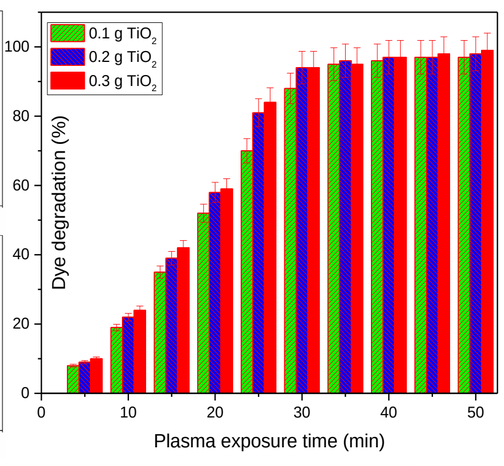
Average particle sizes of simple sol-gel and plasma synthesized TiO_2 nanoparticles.











NOVELTY

- **Plasma assisted sol-gel method proved as a simple, rapid, low-cost and eco-friendly route of production of high-performance nanoparticles.**
- **The average particle size of conventionally produced TiO_2 was 40% larger than plasma assisted sol-gel method.**
- **The maximum dye degradation efficiency of 95% was achieved after 30 min of catalytic plasma treatment.**