Effect of Nitrogen doping on TiO_2 NPs using pneumatic spray pyrolysis method

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Introduction

- The development of well-organized devices and technologies is a necessity due to high demand on energy conversation and storage in the world.

- Photovoltaic (PV) conversion provides a remarkably straightforward and clean means of producing electricity from a raw resource in a one-step process that is carbon-neutral and has no by-products.

- The photoelectrical conversion efficiency of the silicon solar cells has reached to the maximum theoretical power conversion efficiency of 29% in order to expect only small improvements in the future.

Introduction

- However, the cost of electricity manufactured from silicon solar cell as compared other renewable forms of energy still ranks high.

- Hence, it is still a challenge to get solar as a cheaper form of energy.

- Dye sensitized solar cells (DSSCs) employing TiO2 NPs as photo anode are considered as the promising alternative to the expensive silicon solar cells.

Introduction

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- The efficiency of DSSC is lower than 15% so it is very important to enhance the absorption spectrum of TiO_2 into the visible-light region.

- optical, electronic and structural properties of TiO_2 relies on the factors like morphology, surface area, particle size and the nature of dopant.

- Therefore to realise the total potential of TiO_2 for application in devices and solar cells, it is very important to investigate change in nanomaterials properties due to nitrogen doping.

Aims & Objectives

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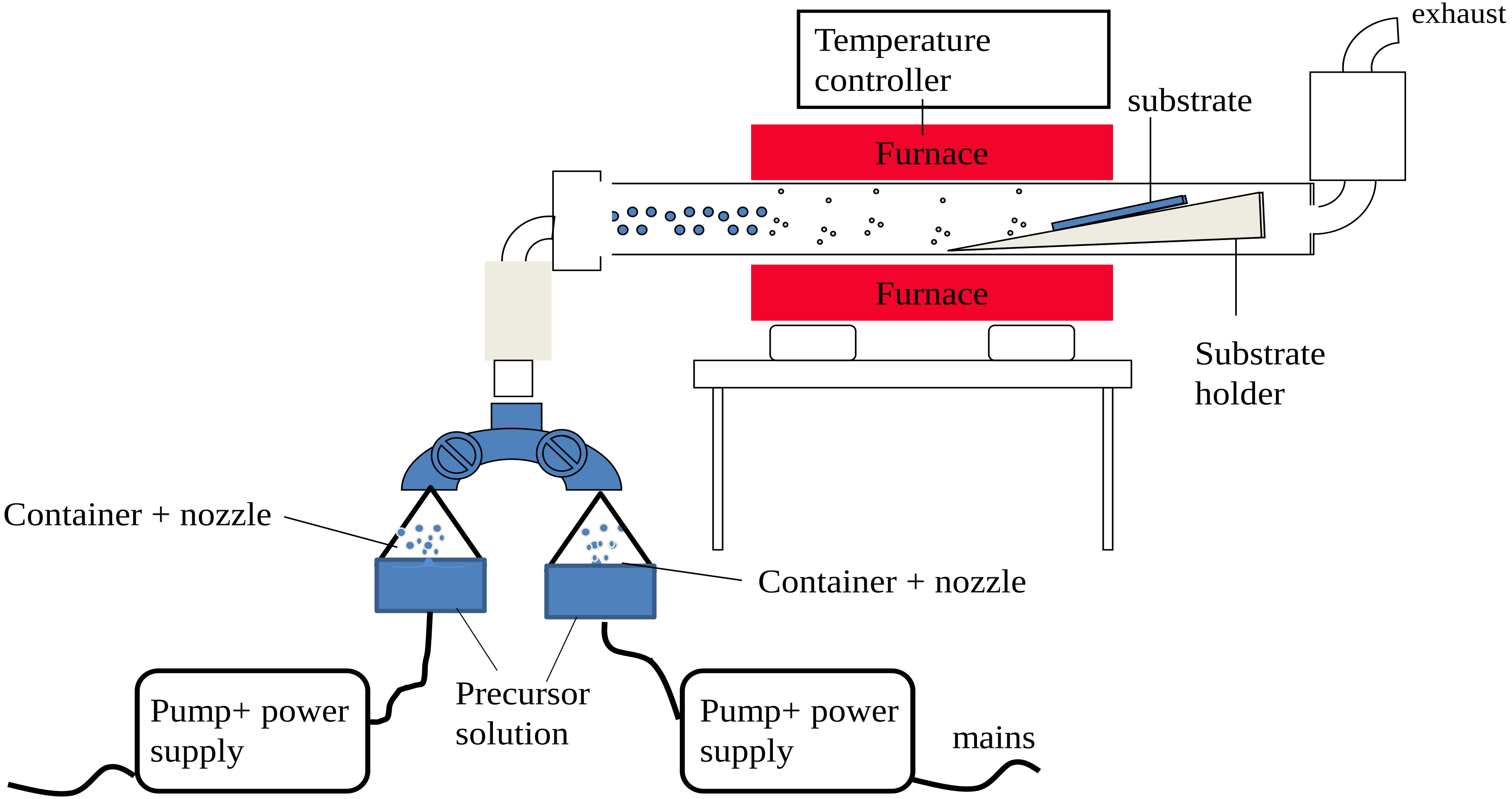
Aim:

- Synthesize Un-doped and N-TiO_2 NPs using pneumatic spray pyrolysis (PSP) technique.
- characterize both un-doped and N-TiO2 NPs using XRD, SEM, Raman spectroscopy and UV-Vis.

Objectives

- Determine the morphological changes in TiO2 as the N-dopant level is varied.
- Determine the crystal structure of the nitrogen doped TiO2(N:TiO2).
- Analyze the optical Raman modes of TiO2 NPs synthesized by PSP.
- Determine whether there are any changes in the absorbance of the TiO2 as doping level increases.

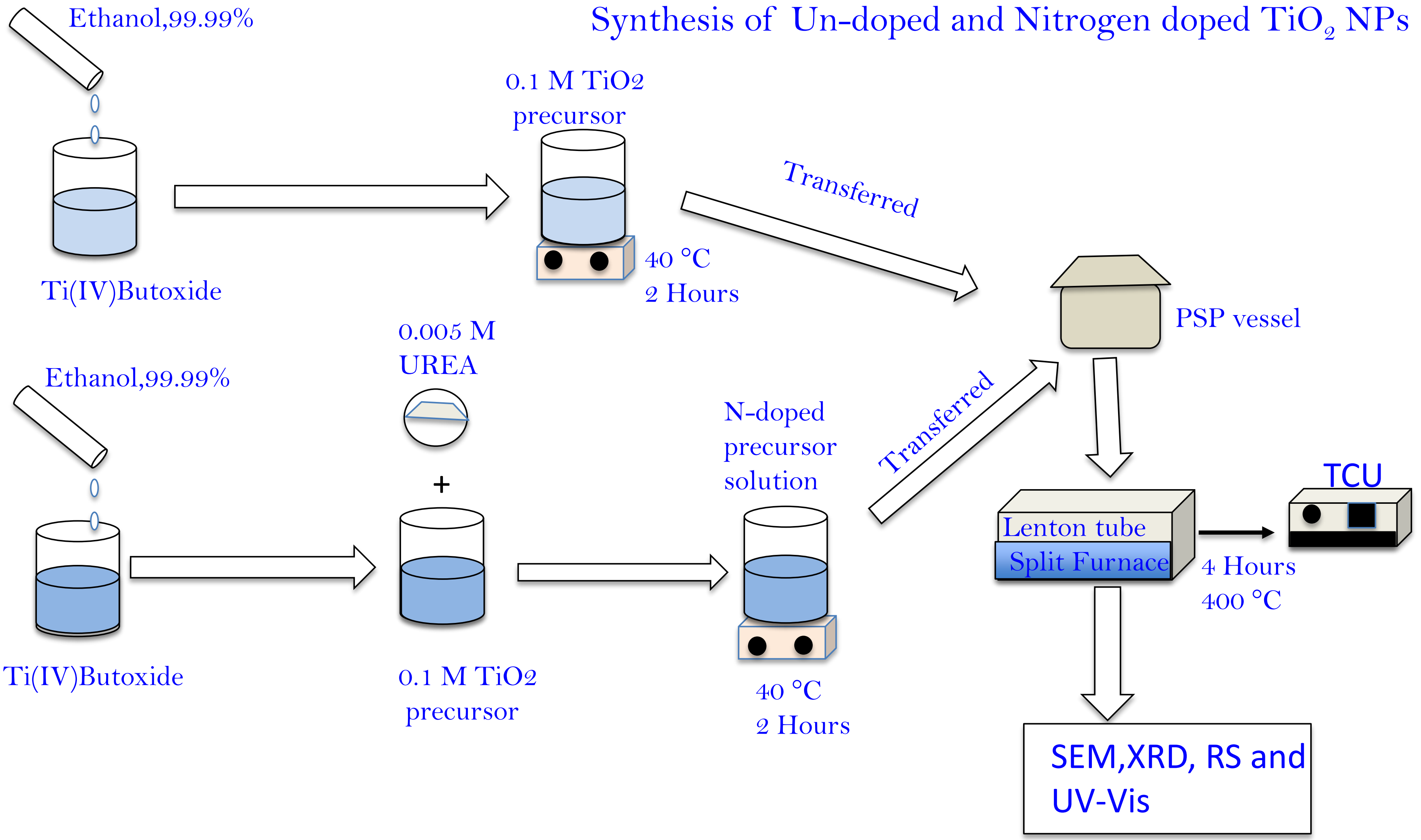
Methodology



- Schematic presentation of the Pneumatic spray pyrolysis system [12]

Methodology

Synthesis of Un-doped and Nitrogen doped TiO_2 NPs



Methodology

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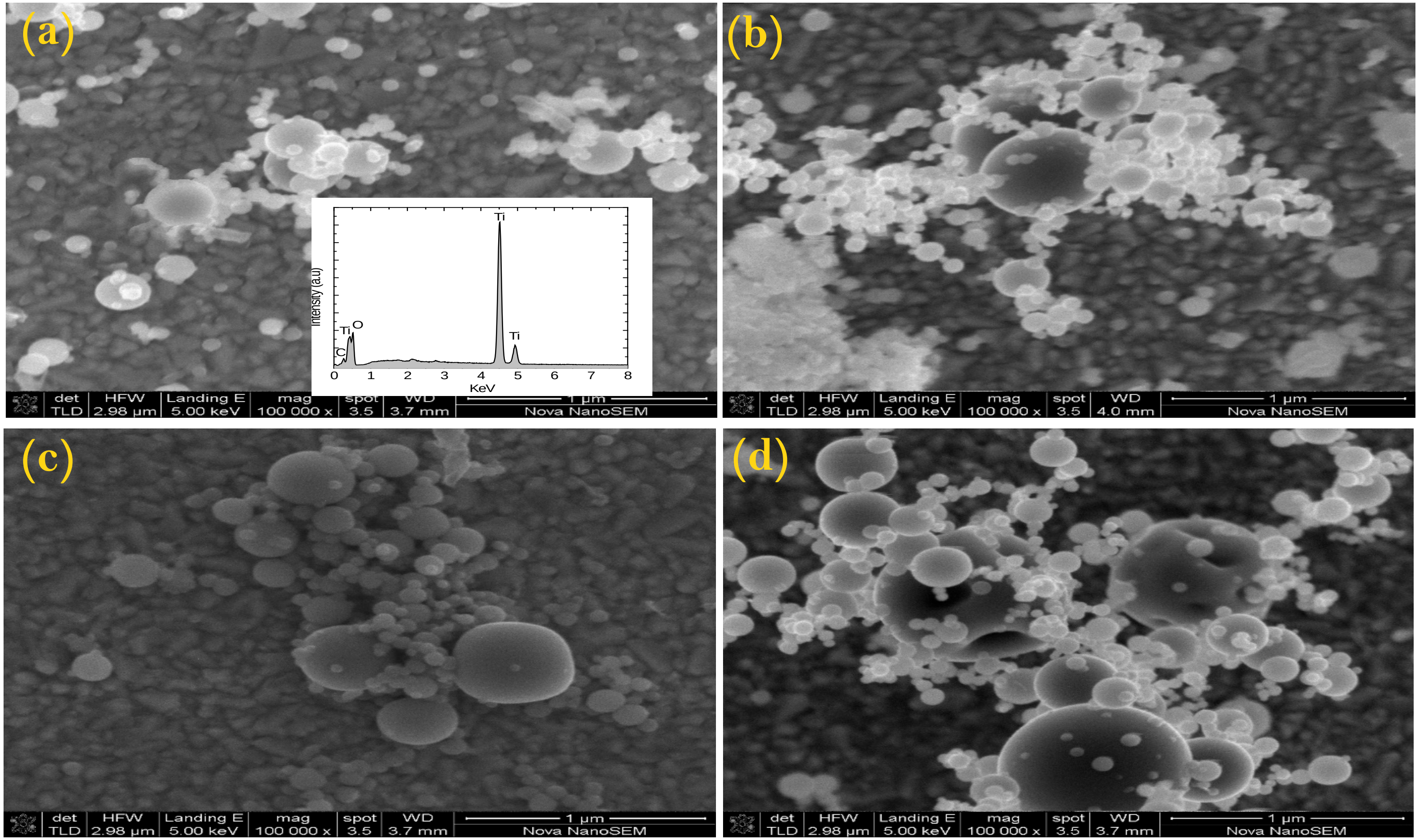
Sample #	Volume of $C_{16}H_{36}O_4Ti$(ml)	Mass of Urea
Un-doped	8.77	0
0.005M N-TiO_2	8.77	0.0075g
0.015M N-TiO_2	8.77	0.022g
0.025M N-TiO_2	8.77	0.037g

Results: SEM



SEM micrographs of (a) un-doped TiO2 NPs and (b) 0.005 M TiO2 (c) 0.015 M N-doped TiO2 NPs and (d) 0.025 M N-doped TiO2 NPs.

Results: XRD

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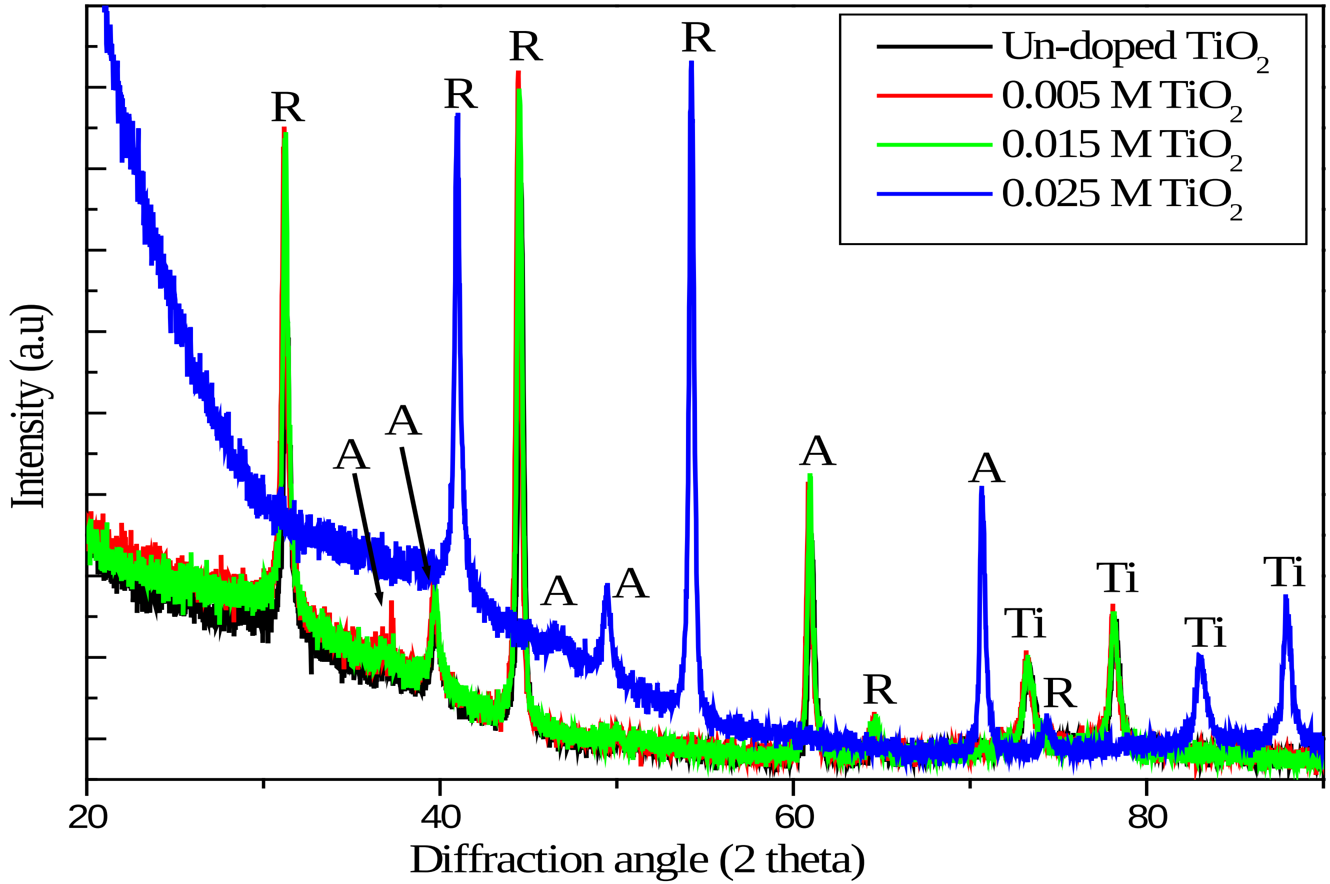
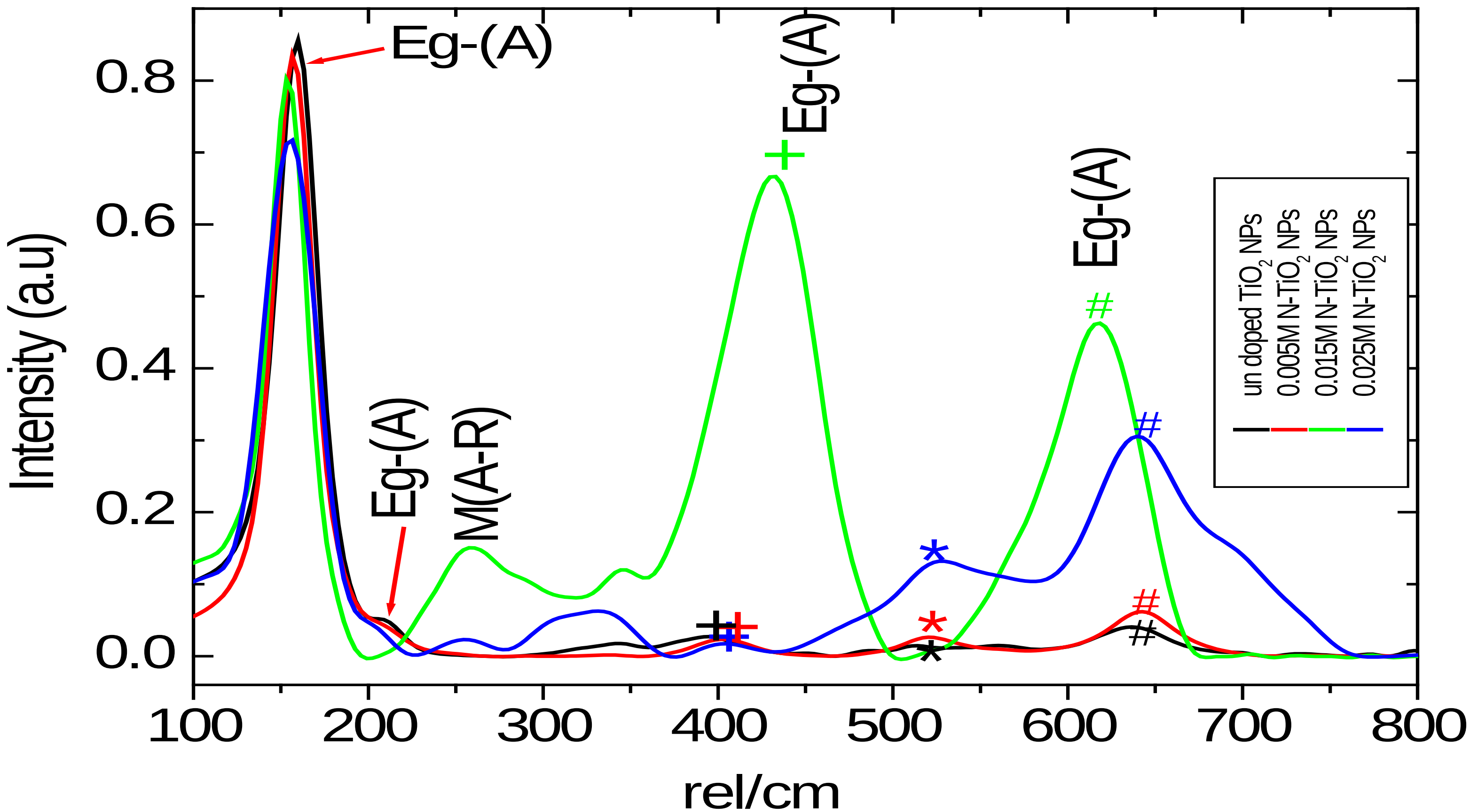


X-ray diffraction pattern of Un-doped and N-TiO2 NPs fabricated by PSP technique.

Results: RS



Raman spectra of the synthesized un-doped and N-TiO2 NPs using pneumatic spray pyrolysis.

Results: UV-Vis

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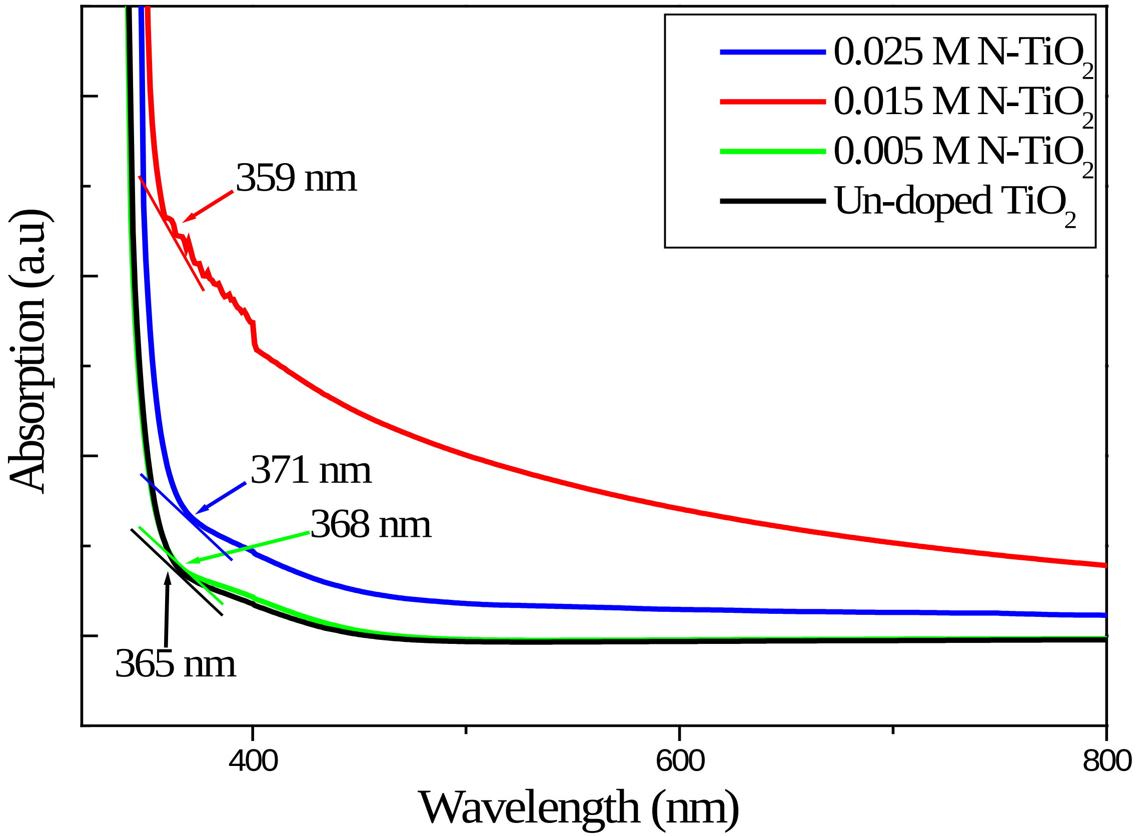

- The as prepared un-doped TiO2 sample has revealed an absorption band gap of 365 nm corresponding to its energy band gap of 3.39 eV.
- The energy band gaps of nitrogen doped TiO2 samples were found to be 3.37 eV (0.005 M TiO2), 3.45 eV (0.015 M TiO2), and 3.34 eV (0.025 M TiO2) which lower than that of the Un-doped TiO2 sample.

UV-Vis absorption spectra of the synthesized un-doped and N- TiO2 NPs

Conclusions

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- SEM analysis revealed that the surface morphology of the PSP synthesized NPs changes with increase in N dopant.
- The XRD revealed that the as prepared un-doped and N-TiO2 NPs has a mixture of anatase and rutile phase and the crystallite size increase as the dopant level increases.
- The Raman spectroscopy of the N-TiO2 NPs has also revealed the characteristics peaks of anatase and rutile phase.
- UV-Vis absorption spectra revealed a red shift in the energy band gap as the concentration of the precursor increases.

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