Sustainability in Nanomaterials Synthesis

By

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INTRODUCTION

- Development of cost-effective and eco-friendly methods for the synthesis of nanoparticles is of great importance.
- Applicable on an industrial scale;
- Sustainability.

- Synthesis of these materials of high purity with controlled size and shape is a major challenge

- Nanoparticles have been obtained by a variety of physical and chemical methods.

- Chemical precipitation, solvothermal, microwave, ultrasound, hydrothermal, and sol-gel methods, etc.s

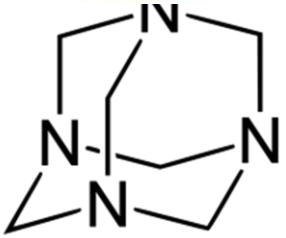
- Techniques require expensive equipment, extra purification steps and long reaction times.

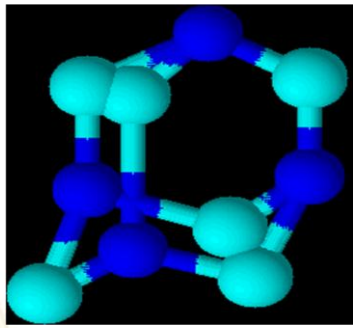
- The development of cost-effective, sustainaible and eco-friendly methods is necessary.

- Synthesis based on readily available, non-toxic and cheap precursors, as well as simple synthetic procedures.

- Proper choice of the precursor, solvents, synthesis method and conditions, could render the technique simple and cost-effective.

- Cheap and readily available.
- A terminal monodentate or as bi-, tri- and tetradentate bridging ligand
- Highly soluble in water and polar organic solvents.





HMTA

$$C_6H_{12}N_4 + 6H_2O \longrightarrow 6CH_2O + 4NH_3$$

$$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$$

- A naturally available and sustainable resource (*Averrhoa carambola L.*) for the synthesis of metal and mixed metal oxalates.
- The fruit juice is used directly without initial purification steps or prior extraction of the acid.
- product is obtained by directly mixing the metal ion solution and the juice

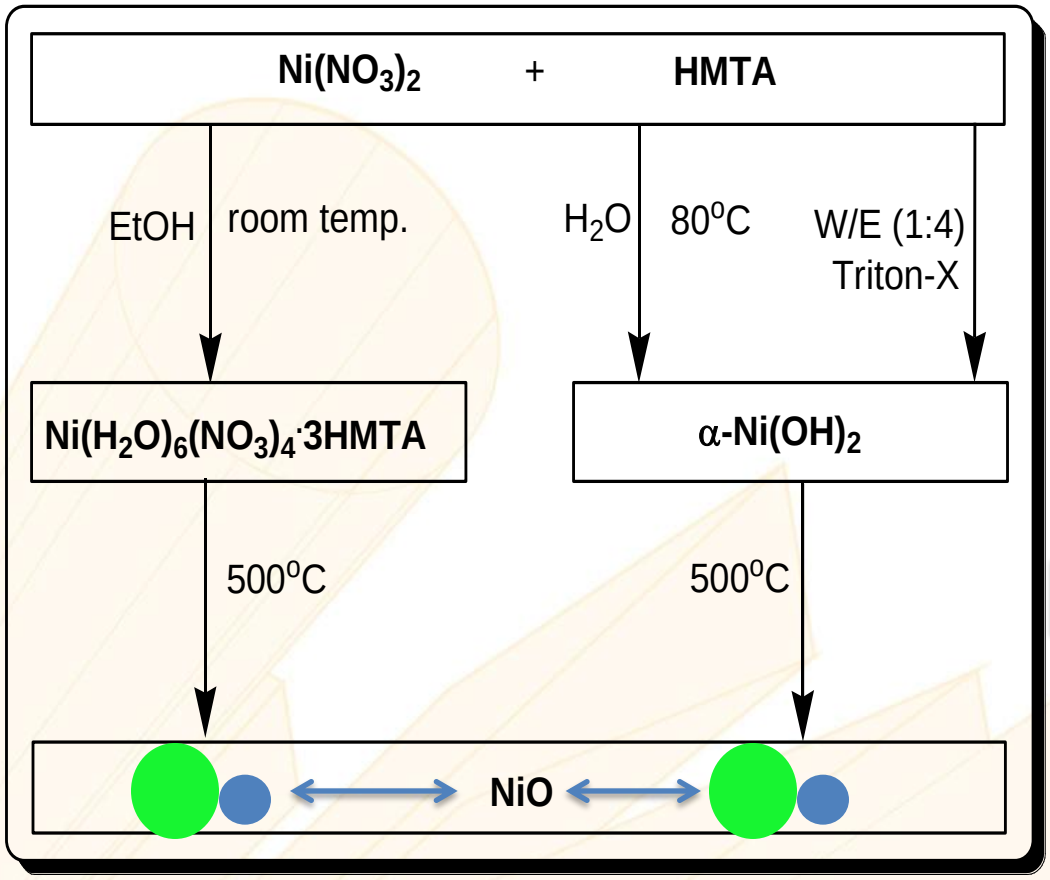
OBJECTIVES

- Investigate the effect of synthesis conditions on the size ,morphology and properties of various metal oxide nanomaterials;

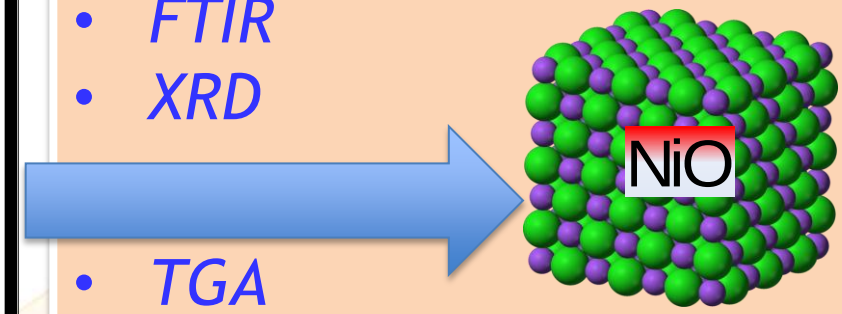
Variables include:

- Inorganic precursor, Solvent system, Temperature,Surfactant template.

EXPERIMENTAL



- **Characterization**
- *Elemental analyses (C,H,N,Ni);*
- *High resolution mass spectrometry;*
- *FTIR*
- *XRD*



- *TGA*
- *SEM/EDX*
- *TEM*
- *Nitrogen physisorption (N_2-BET)*

RESULTS

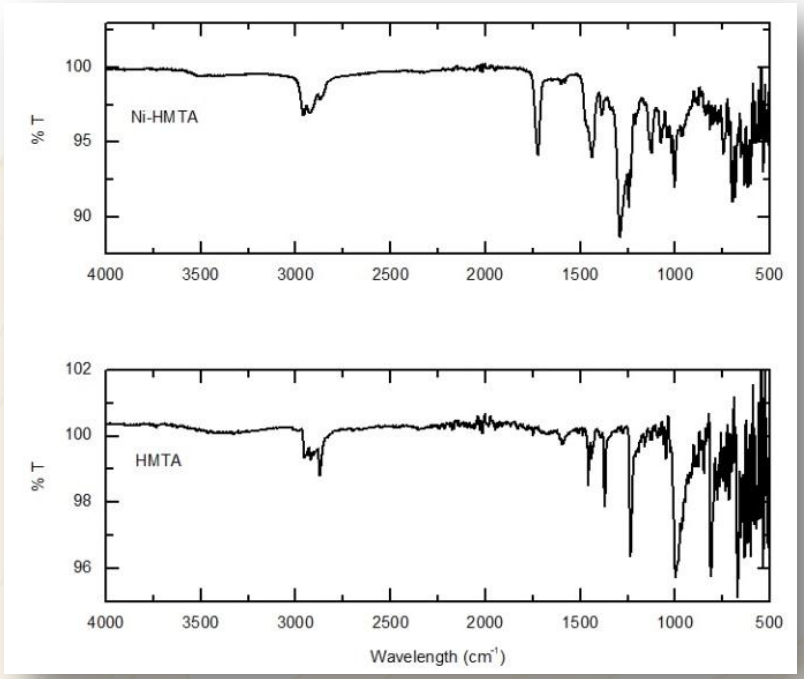


Fig.2: FTIR of HMTA and Ni-HMTA precursor

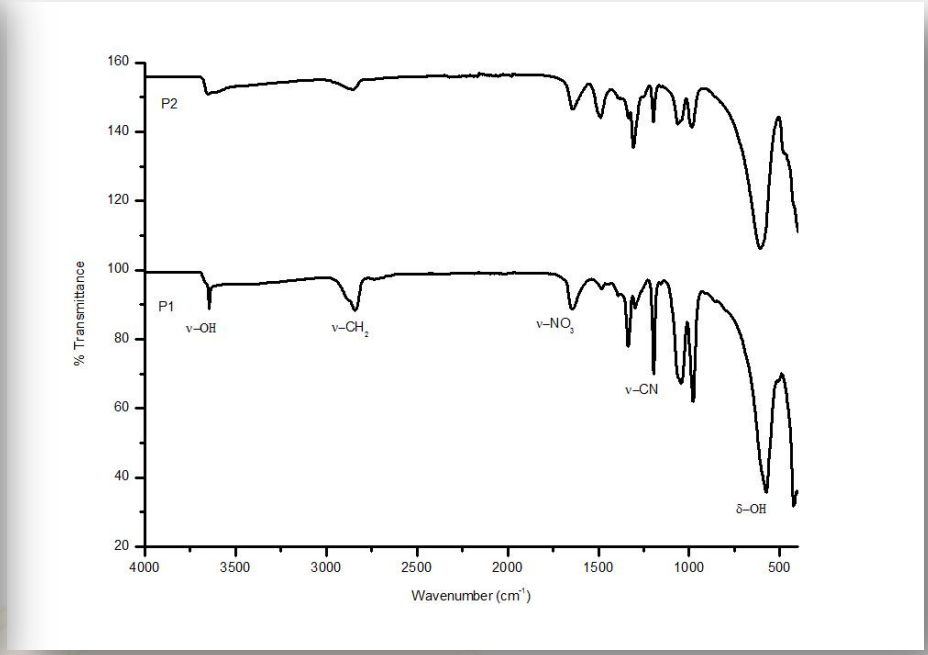


Fig. 3: FTIR spectra of $Ni(OH)_2$ precursors

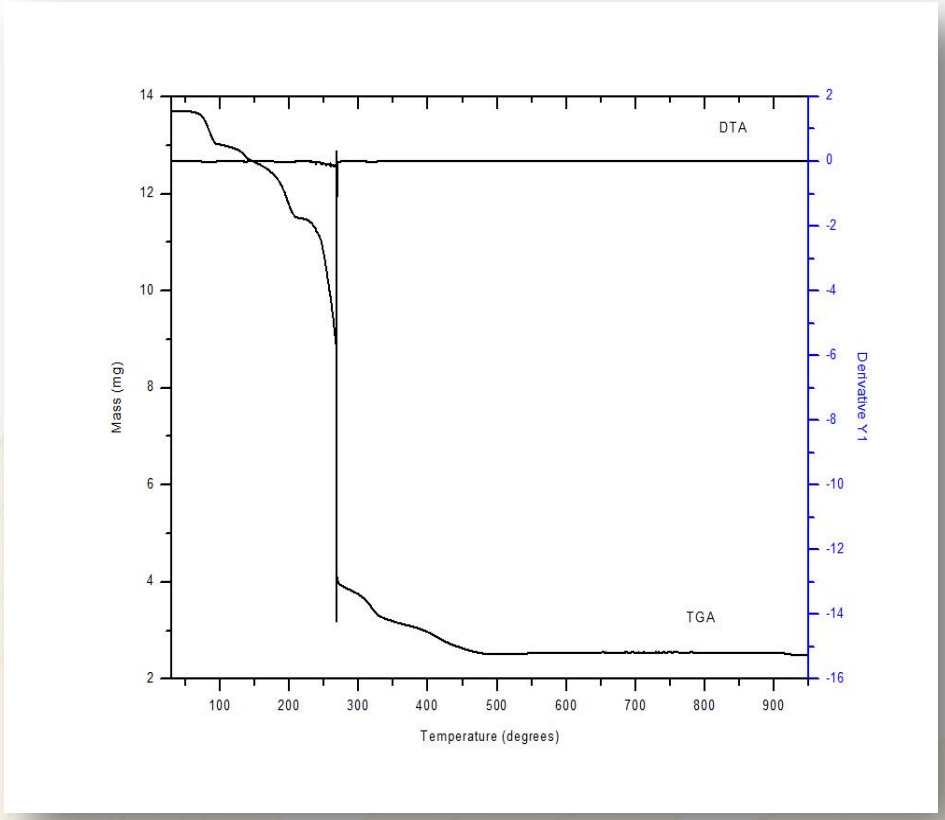


Fig. 4: TGA/DTA of Ni-HMTA complex

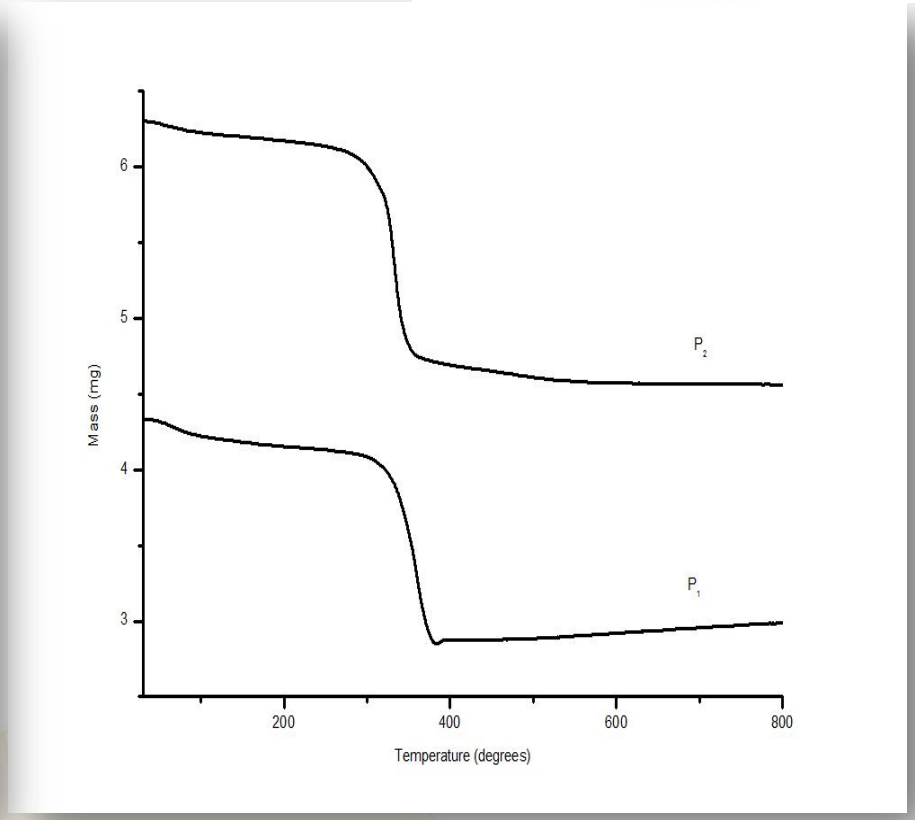


Fig. 5: TGA/DTA of $Ni(OH)_2$ precursors

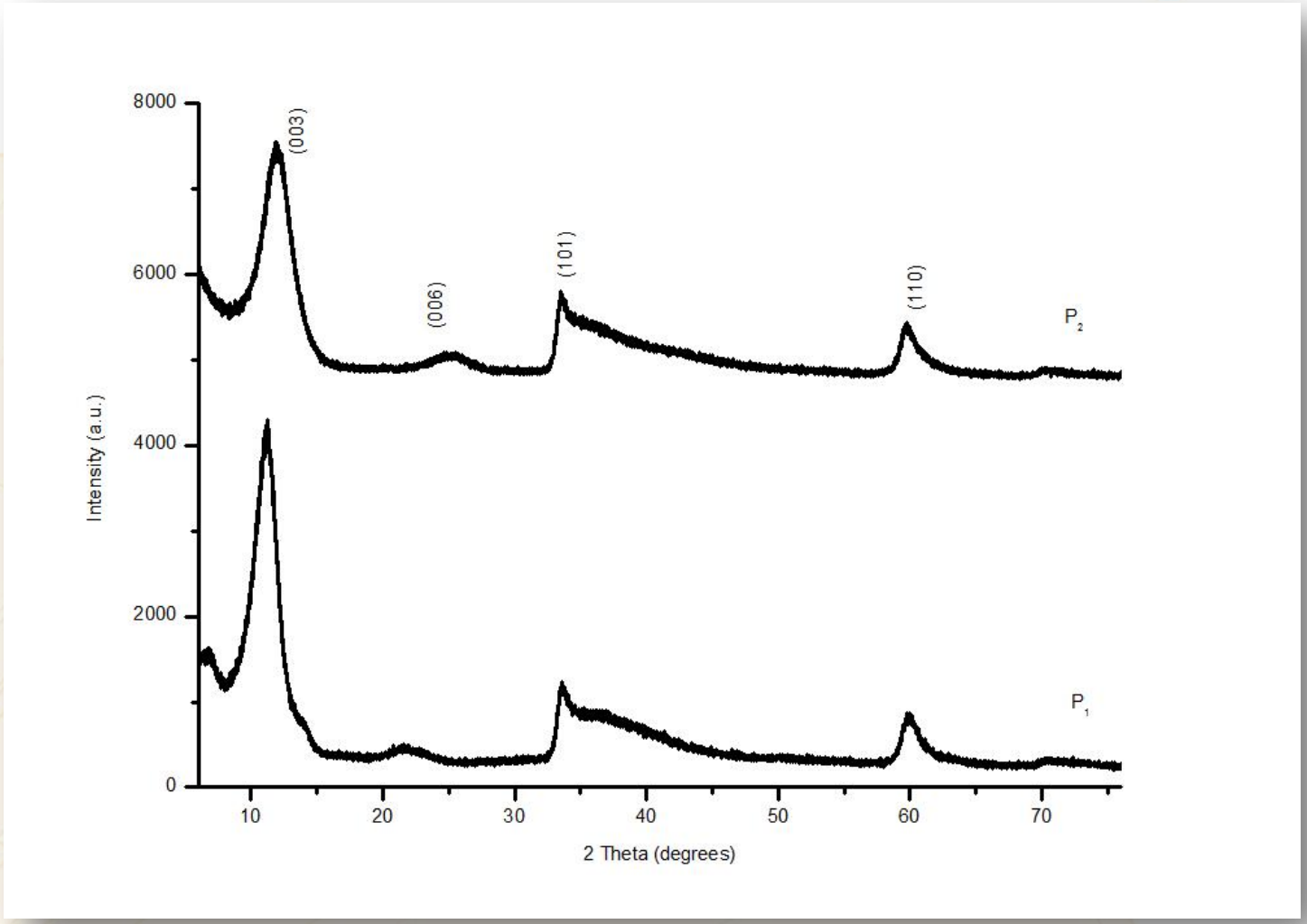


Fig. 6: XRD patterns of $Ni(OH)_2$ precursors

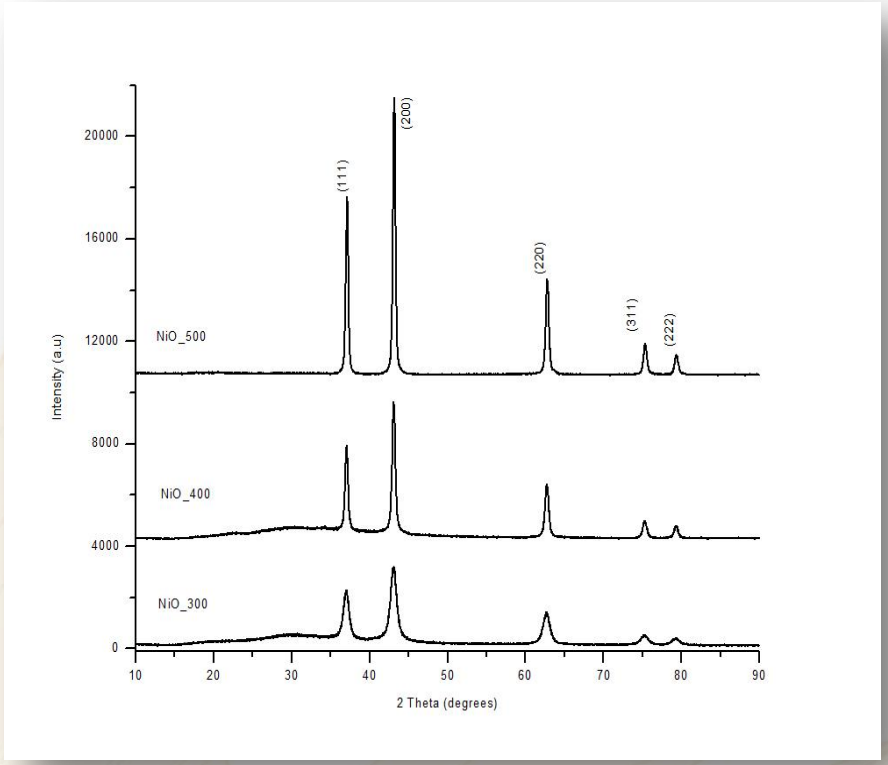


Fig. 7a: XRD pattern of NiO obtained from Ni-HMTA complex

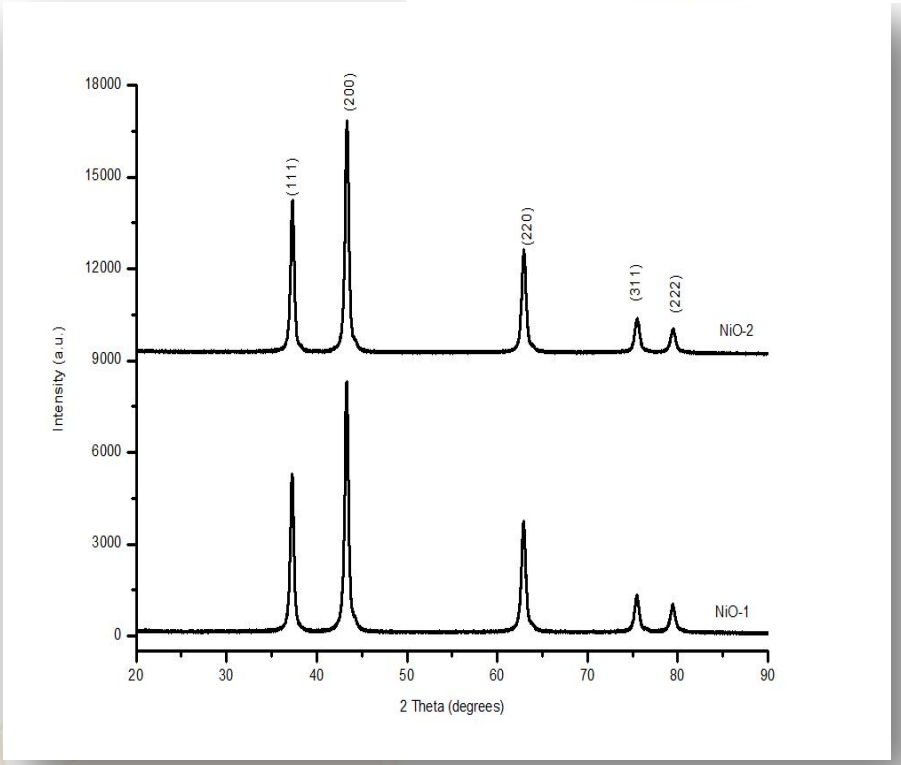


Fig. 7b: XRD pattern of NiO obtained from $Ni(OH)_2$

- **Crystallite size calculated from the (200) peak, using Debye-Scherrer equation, indicate average particle sizes of 22 and 17 nm**

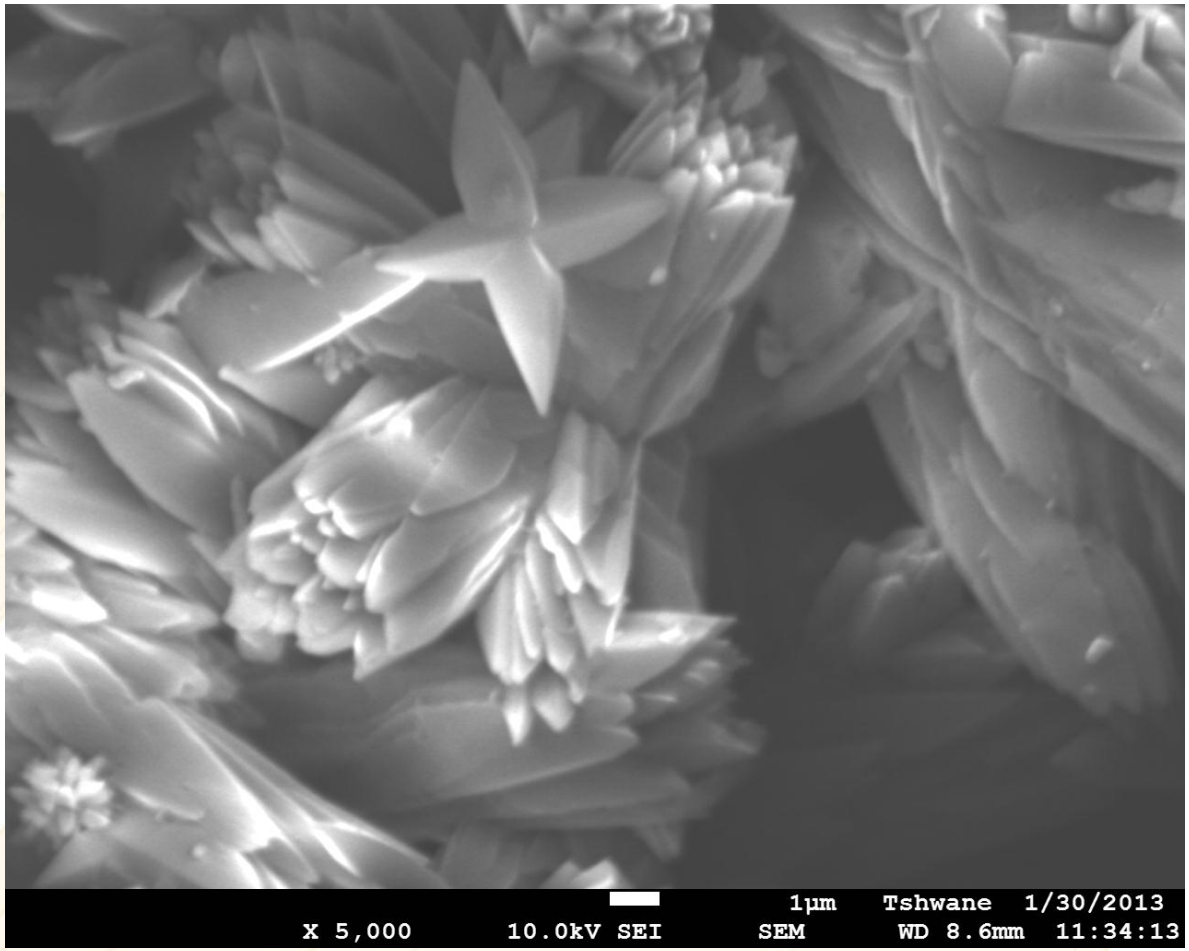


Fig. 8: SEM image of Ni-HMTA precursor

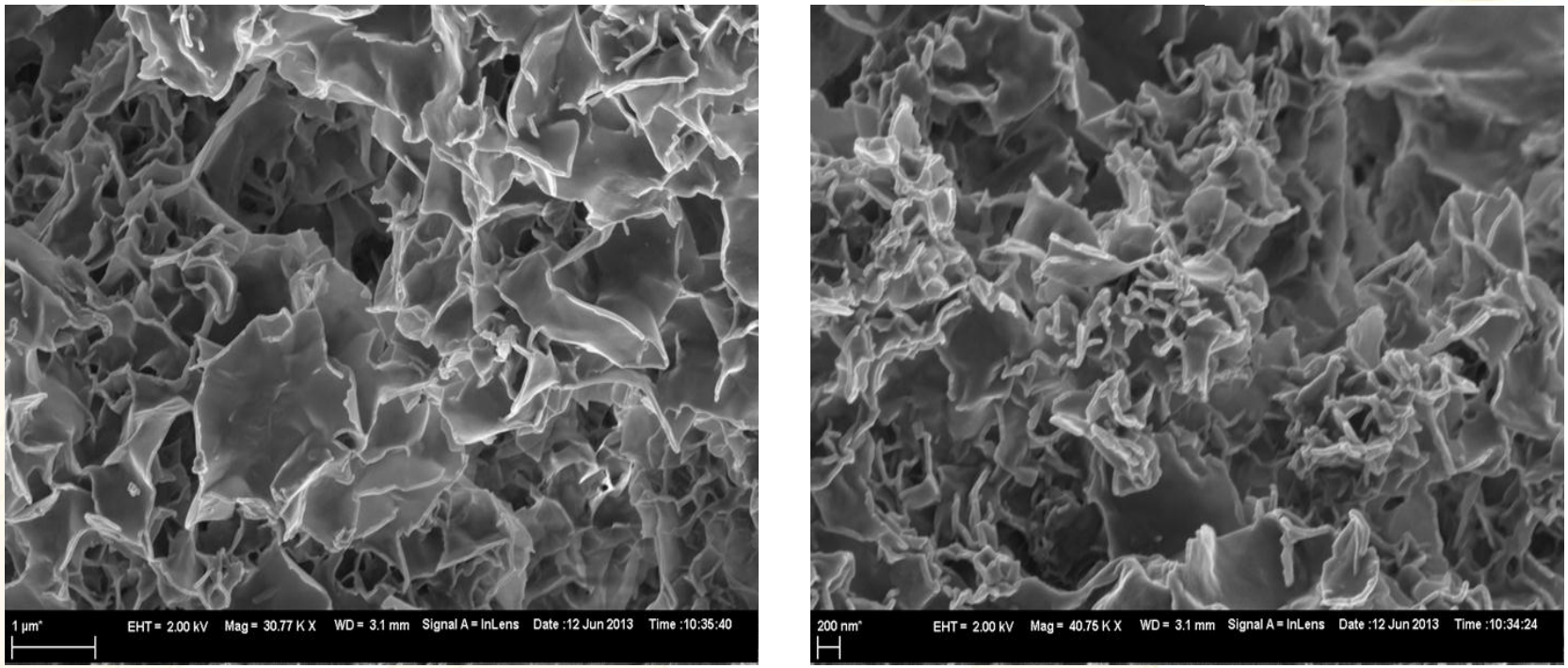


Fig. 9: SEM images of $Ni(OH)_2$ precursor P_1

- Leaf-like morphology for the precursor.
- Structure of the precursor is porous.

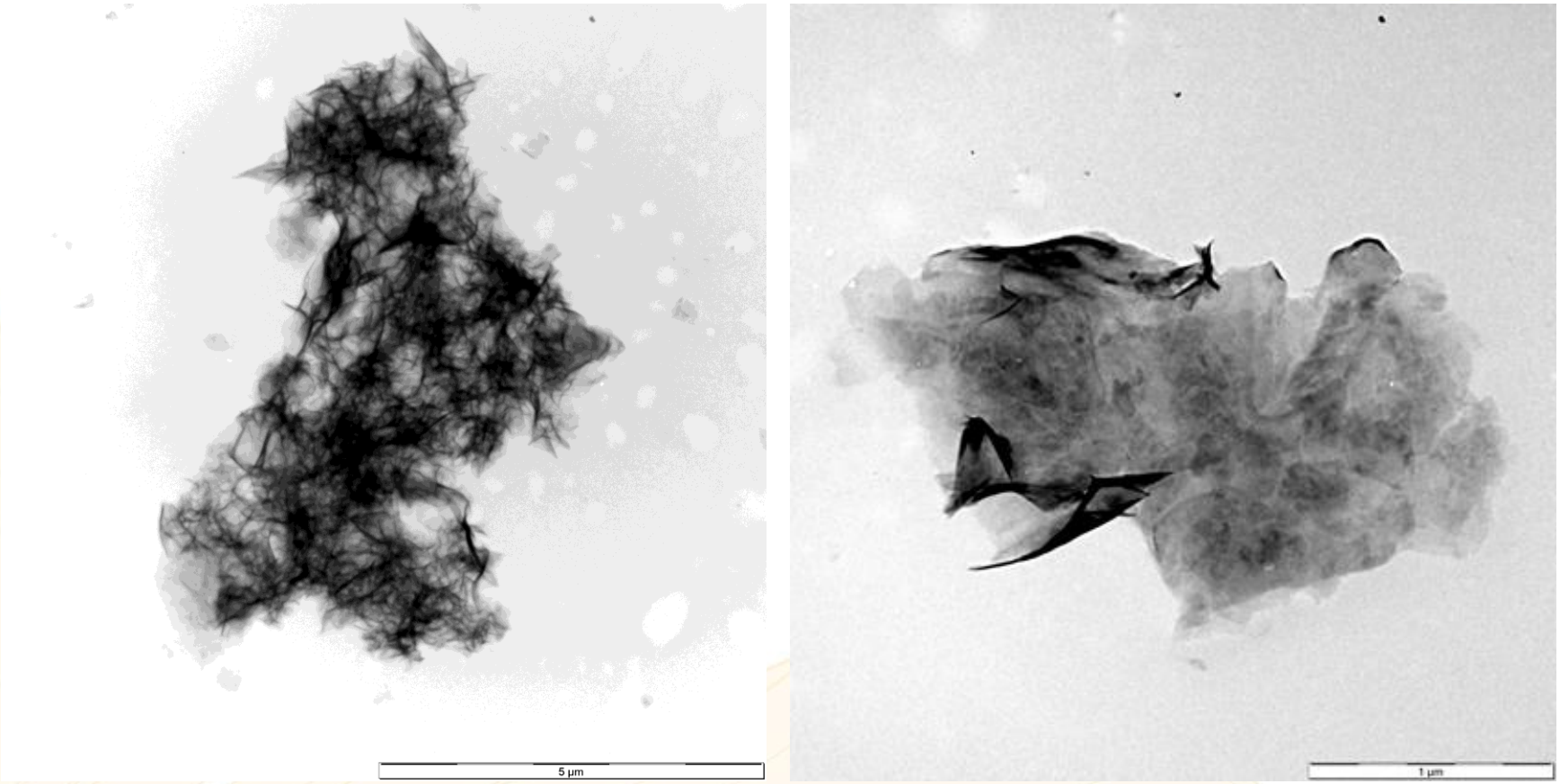


Fig. 10: TEM images of $Ni(OH)_2$ precursor P_1

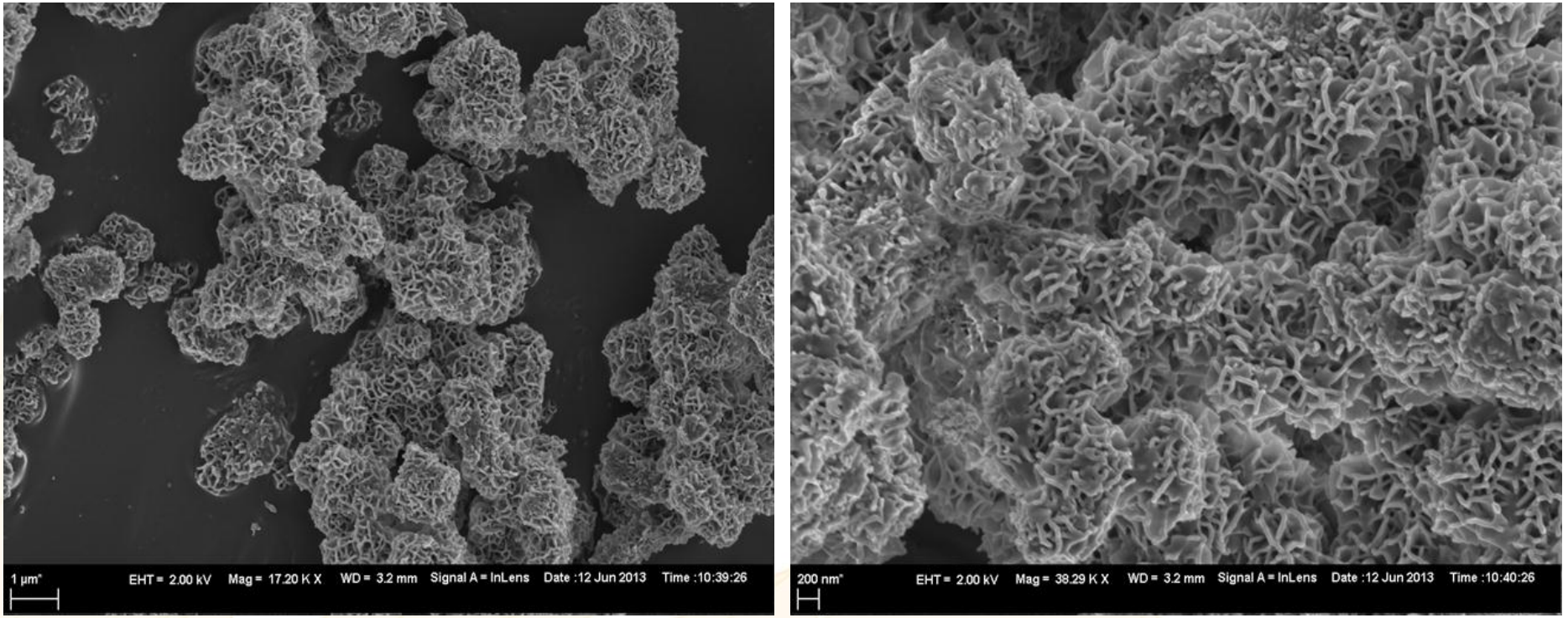
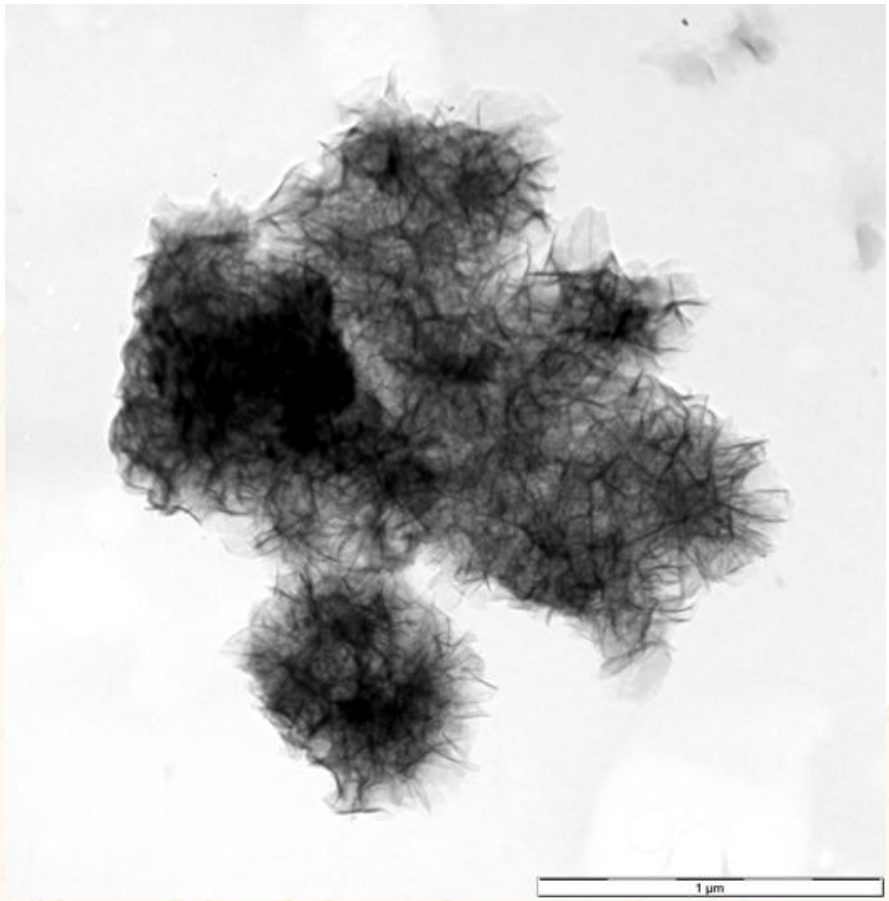


Fig. 11: SEM images of $Ni(OH)_2$ precursor P_2

- Flower-like morphology for the precursor



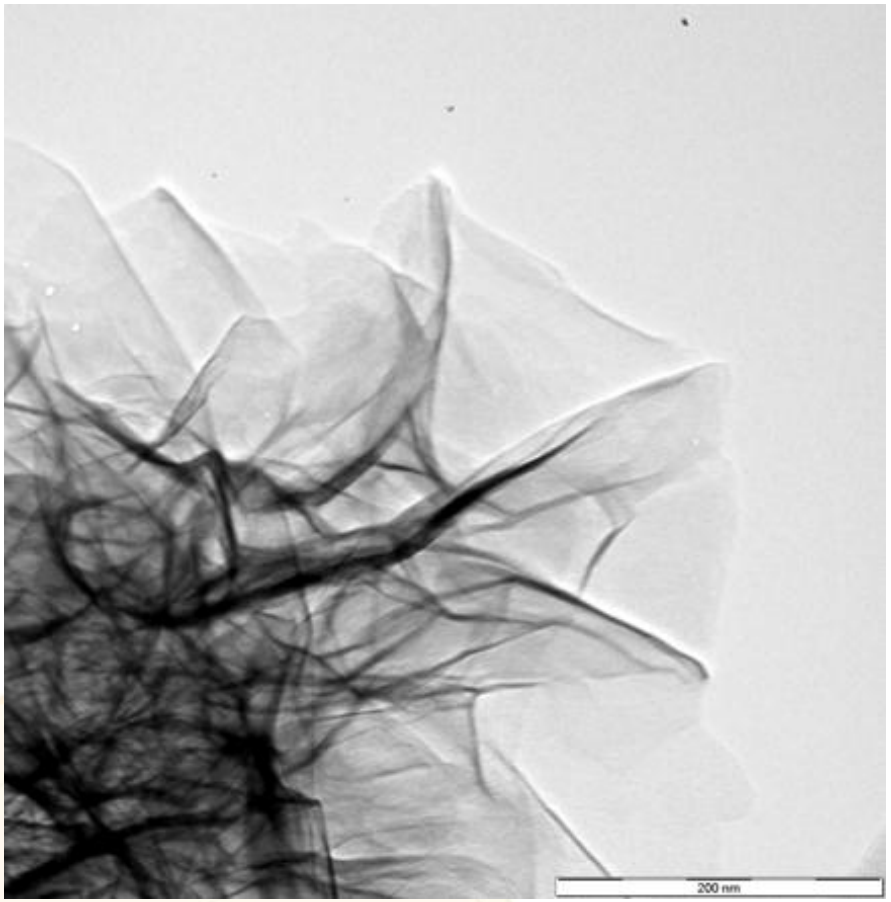


Fig. 12: TEM images of $Ni(OH)_2$ precursor P_2

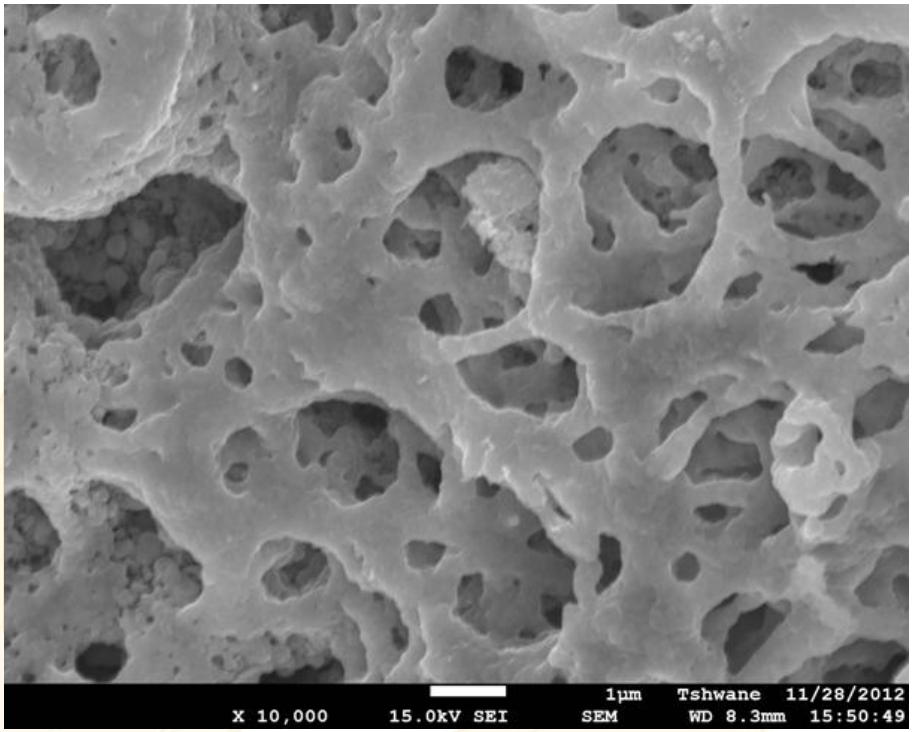


Fig. 13a: SEM image of NiO obtained from Ni-HMTA complex

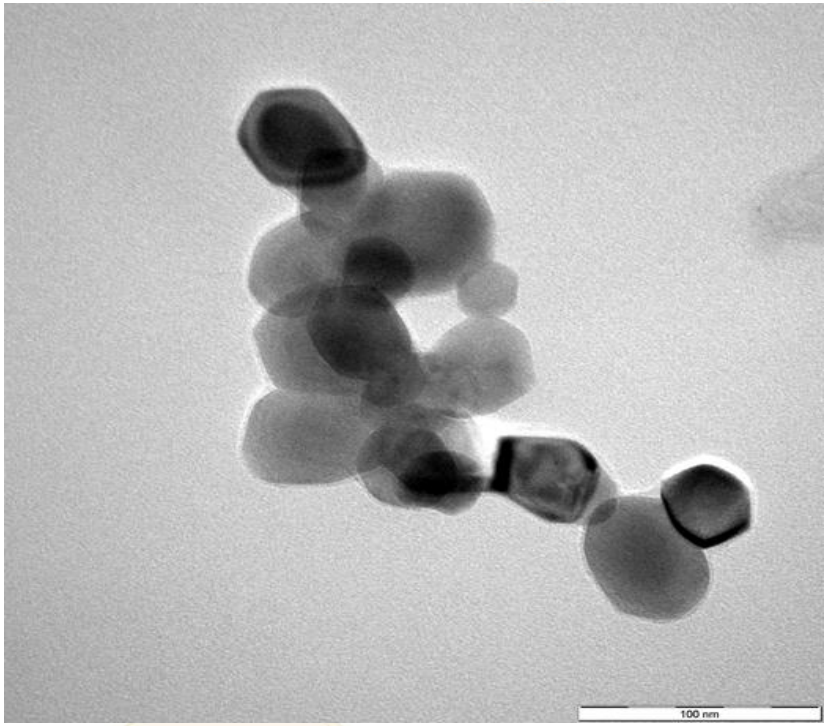


Fig. 13b: TEM image of NiO obtained from Ni-HMTA complex

- TEM shows a transition from cubic to hexagonal shape.
- Average particle size is 20.2 nm after lognormal fitting.

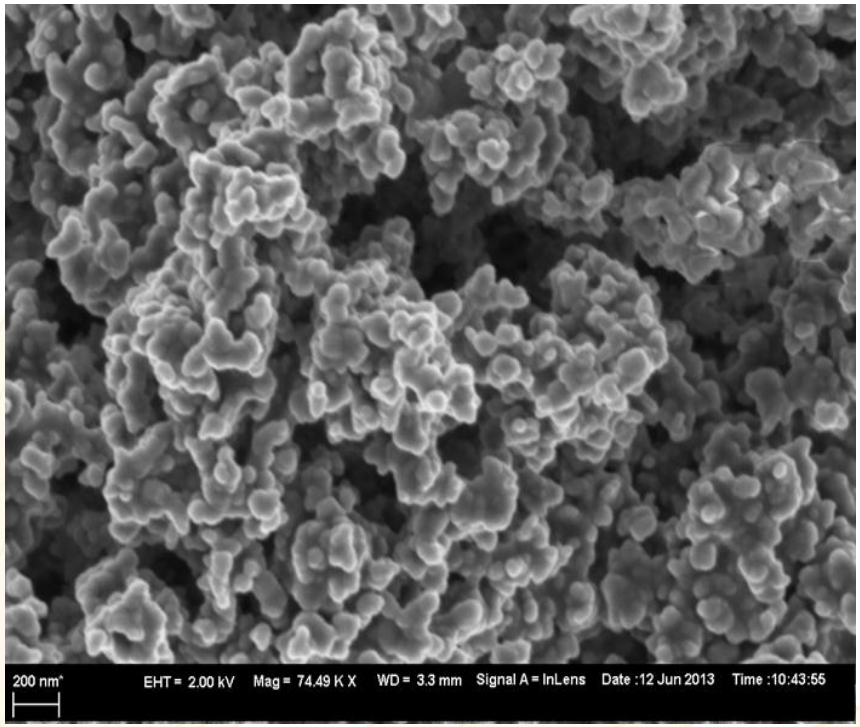


Fig. 14a: SEM image of NiO-1

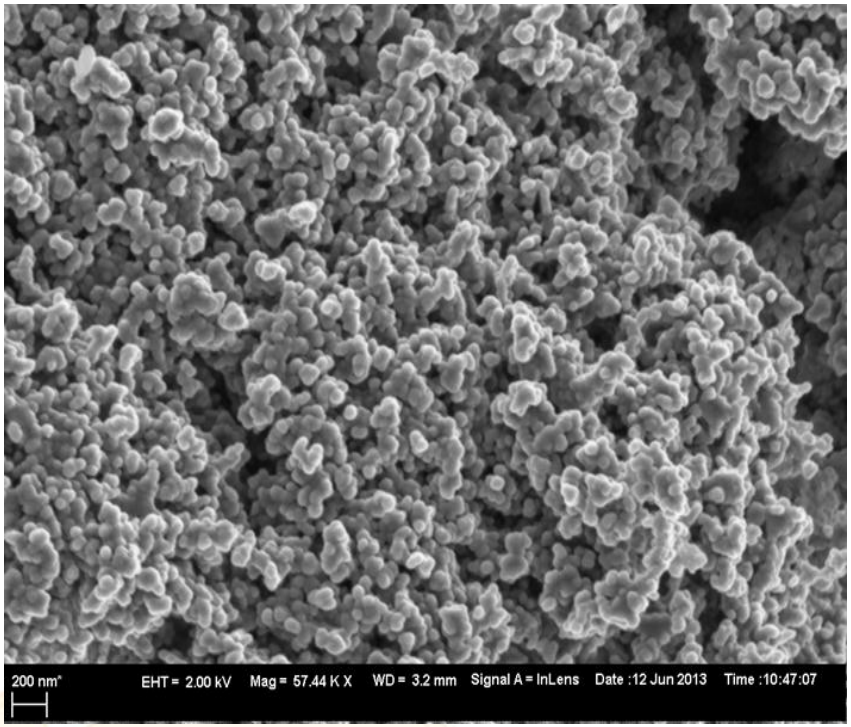


Fig. 14b: SEM image of NiO-2

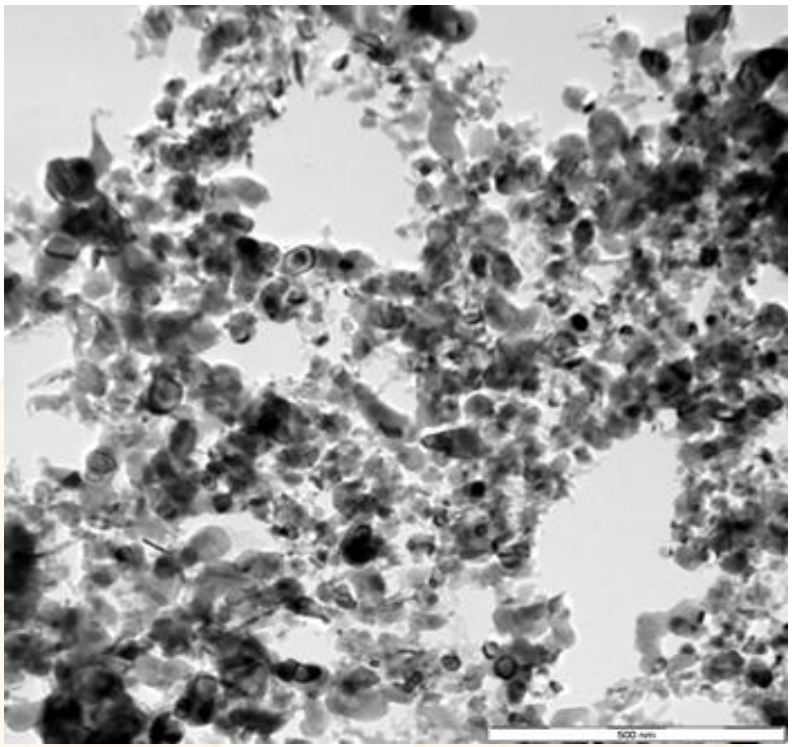


Fig. 15a: TEM image of NiO-1

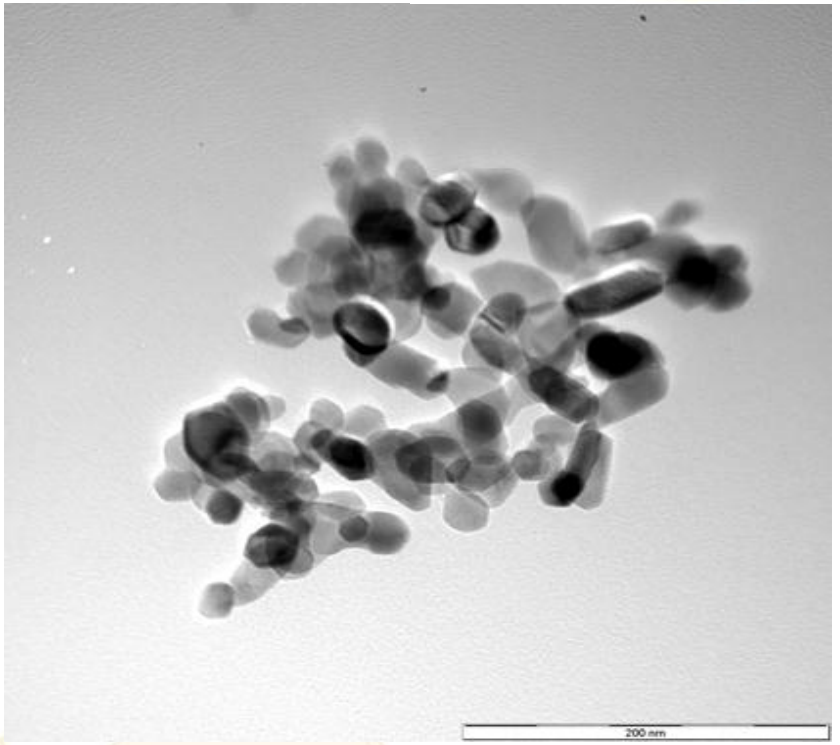
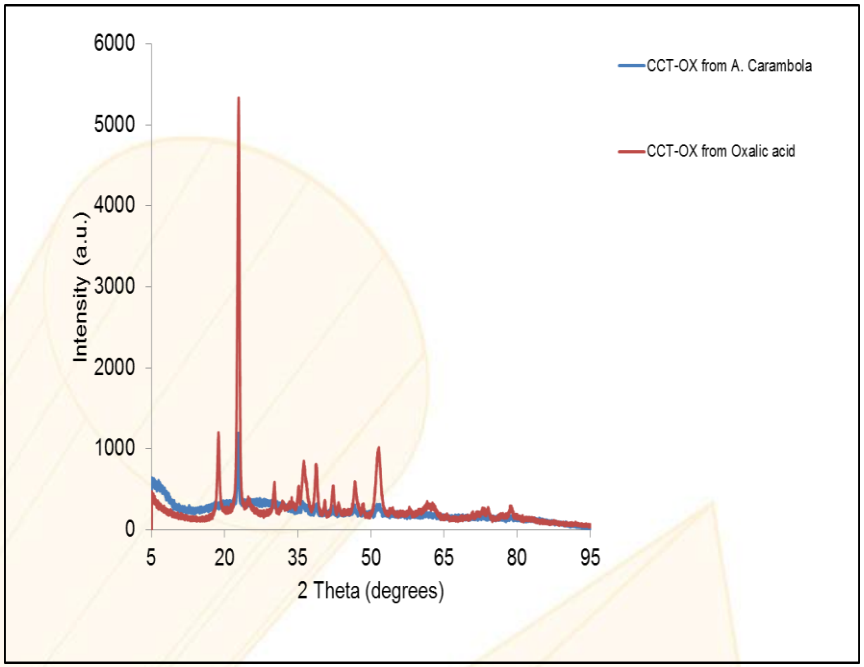


Fig. 15b: TEM image of NiO-2

- NiO-1 has a cube-like morphology with average particle size of 15.1 nm.
- NiO-2 has a rod-like morphology.



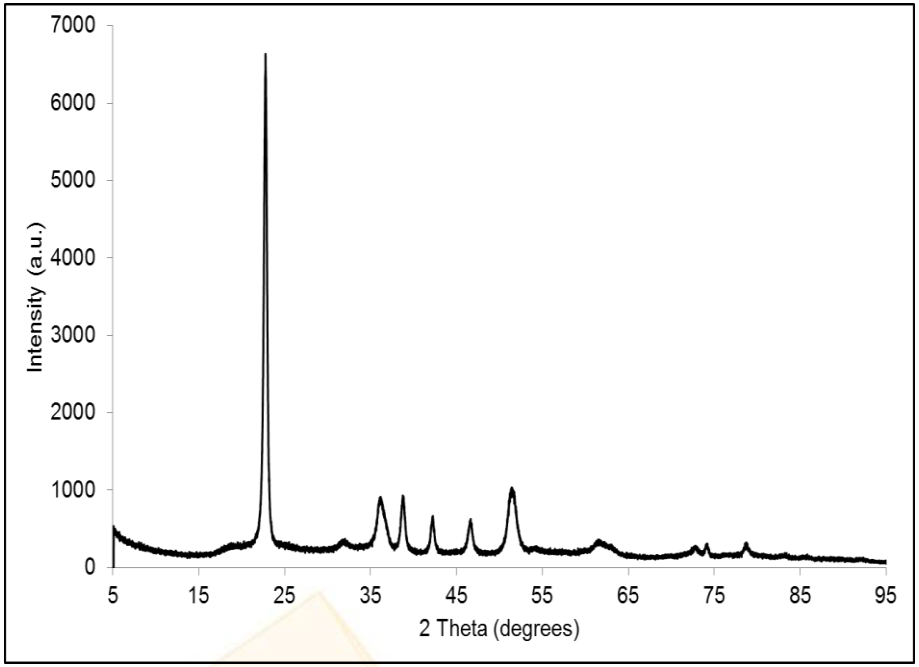


Fig. 16a: XRD of CCT-Ox

Fig. 16b: XRD of CCTO

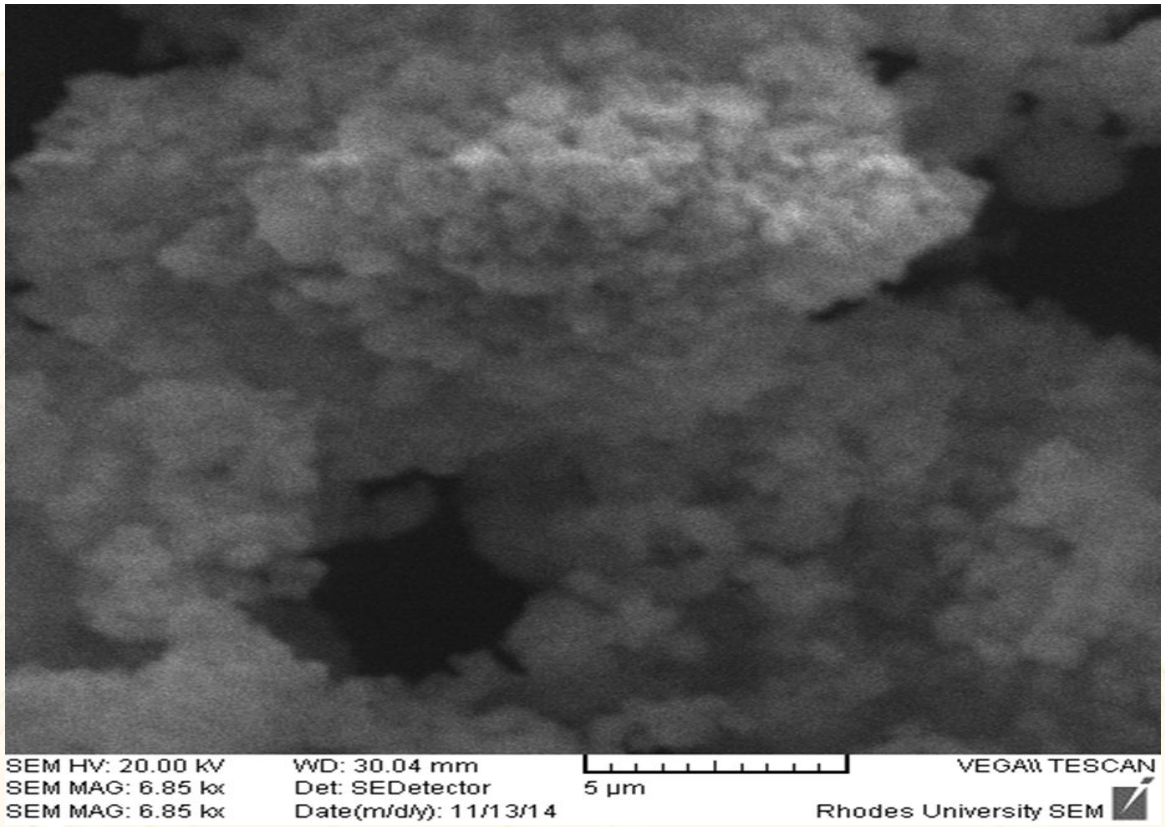


Fig. 17: SEM of CCTO

THANK YOU FOR YOUR KIND ATTENTION!!!