**Synthesis and Characterization of WO3 Nanoflakes**

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**ABSTRACT**

In this research, we synthesized WO3 nanopowder by chemical bath deposition. Here, we studied the optical, structural, morphological and compositional properties of WO3 nanopowder. X-ray diffraction analysis shows a hexagonal crystal structure with a crystallite size of 72 nm. The SEM micrograph shows a nanoflake-like morphology. The EDS spectra show the presence of tungsten and oxygen in good agreement with the standard data.

**Introduction**

Tungsten oxide has received much attention in recent years for its electrochromic, photocatalytic, photoluminescent, and gas sensing properties [1, 2]. The electrochromic property, of all these characteristics, is most emphasized as WO3, the film has the ability to undergo optical coloration when a voltage is applied. WO3 has been widely studied extensively for their photoelectric performance due to their better photoconversion efficiency. WO3 is the most promising functional material and plays a key role in the PEC performance of solar cells. Interestingly, the photoelectrochemical performance of WO3 is greatly influenced by its structure. There are a number of approaches to the production of WO3 nanorods, nanowires, nanofibers, nanoneedles, nanospheres, etc. the study of all these morphologies leads to remarkable physicochemical properties [6-10]. The preparation of WO3 thin film with controlled morphology is a difficult task. In this regard, the hydrothermal method provides a better opportunity for the size and morphology of W03. Of all these, WO3 is the most studied because it offers a number of advantages such as chemical stability, low cost, non-toxicity, high refractive index, long life, wide band gap. Nowadays, WO3 has become the most important functional material in many applications such as photocatalysis, dye-sensitized solar cells, sensors, ion absorbance, Li-ion batteries, dielectrics, ceramics, etc.



**Fig. 1WO3 Nanopowder**

**Experimental**

200 mL of distilled water was poured into the beaker. 13.3 grams of Na, WO, 2H 2 O (sodium tungstate) were weighed on a balance, added to a beaker containing distilled water and stirred thoroughly until a clear solution appeared. Hydrochloric acid (HCl) was added to the solution to give yellow precipitates; Excess HCl was added to complete the reaction (all dissolved sodium tungstate particles were precipitated). The precipitates were then filtered using filter paper. After filtration, the precipitates were dried on filter paper inside the oven so that the filter paper was not damaged by the action of HCl. The dried precipitates were then separated in a dish and stored.

**GROWTH AND REACTION MECHANISM**

In the current research work, WO3 nanopowder is synthesized. Here, WO3 is prepared by a simple chemical growth method using sodium tungstate and the precursor is hydrochloric acid. The following reactions take place during the formation of WO3,







Initially, sodium tungstate is a white powder. It is soluble in water and dissociates to form tungsten ion. Another tungsten ion reacts with the hydronium ion to form white tungstic acid. Here, white tugstenic acid yields tugsten oxides on heating. New structural properties of nanomaterials are attributed to the process of their growth. Here, nucleation and particle size control are the main aspects of the growth mechanism

**X-RAY DIFFRACTION**

X-ray diffraction studies are generally performed to determine the crystal structure of a solid-state material, either nanocrystalline, polycrystalline, or amorphous. In the present studies, X-ray diffraction studies were performed using an X-ray diffractometer [Bruker AXS Model D8 Advance X –ray Diffractometer] with a Cu Ka target at a wavelength of 1.542 A°.

The XRD plot for WO3 thin is shown in Figure . The XRD pattern of the film shows diffractions at 29 (Bragg angle) = 13.10°, 22.23°, 23.63°, 27.60°, 32.96°, 35.93°, 49.24°, 55.01o and 57.900, corresponding to 57.900°, (110), (200), (112), (202), (004), (222), and (312) planes of hexagonal WO3 according to JCPDS No. 85-2459 for the hexagonal crystal structure. The calculated crystallite size is 72.0 nm.

C:\Users\USER\Desktop\WO3 Project\Picture1.tif

**Fig. 2. X-ray Diffraction Pattern**

**Morphological Study**

Morphology is the most important characteristic of a nanomaterial. Morphology is of particular importance because it reveals the physical and chemical properties of nanomaterials. SEM analysis is performed to study the morphological aspects of WO3 nanomaterial. SEM images of the WO3 nanomaterial show a well-adherent, uniform formation without holes. The morphological study is performed at low and high resolution. Low-resolution photomicrographs show a nanoflake-like morphology. Numerous nanoflakes are aggregated together to form a dense structure.

**Fig. 3. SEM micrographs of WO3 thin films**

**Compositional analysis**:-

EDS is performed to determine the chemical composition of the nanomaterial in the current research work. We have synthesized WO3 nanopowder, so EDX analysis is performed to confirm the atomic percentage of tungsten and oxygen. The observed atomic percentage of tungsten is 19% and oxygen is 81%. The observed percentage is in good agreement with the standard data. No extra peak due to impurities observed in the chemical composition.



**Fig. 4. EDS Spectra of WO3**

**Conclusions:-**

The WO3 nanopowder is synthesized by chemical growth method. The XRD pattern confirms hexagonal crystal structure. The SEM images show nanoflake like morphology. The EDS spectra confirms presence of tungsten and oxygen. All these results reveals that WO3 is a better candidate for electrochromic applications.

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