# Morphological and Structural Characterization of ZnO and $TiO_2$ Nanoparticles

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**Abstract**

This work deals with the characterization study of structural and morphological features of Zinc oxide and Titanium dioxide nanoparticles to better understand their role in anomalous properties of nanofluids and ionanofluids. These nanoparticles were purchased from *IoLiTec* (Ionic Liquids Technologies, Germany) and they have numerous potential applications such as in electrodes for solar cells, photocatalytic decontamination, piezoelectrics, pigments for paints, photochemical degradation, catalysts and catalyst supports, and UV protection. In addition, these nanoparticles laden nanofluids and ionanofluids can be used for advanced heat transfer and green energy-based applications [1-4]. Both the nanofluids and ionanofluids are new classes of fluids which are prepared by dispersing nanoparticles in conventional thermal fluids and ionic liquids, respectively [1, 3-4]. Using these nanoparticles we aim to prepare ionanofluids and to investigate their various properties. However, prior to studying any properties or applications of nanofluids or ionanofluids, it is crucial to have clear information about morphology and structures of the nanoparticles to be dispersed.

The morphology and size of nanoparticles was studied by using a high resolution transmission electron microscopy (TEM) (FEI Technai F30) at an acceleration voltage of 300 kV. In order for TEM study, very dilute suspensions of nanoparticles in ethanol was prepared before placing and drying out the sample on carbon coated copper grid. The TEM images in Fig.1 show the morphology and structure of nanoparticles. It can be seen that while $TiO_2$ nanoparticles are not fully spherical, ZnO are of spherical shape. The average sizes of ZnO and $TiO_2$ nanoparticles were found to be about 15-20 nm and 35-45 nm, respectively and they are very close to the initial sizes of these nanoparticles provided by the company. Although nanoparticles are found to be of uniform sizes, they form aggregation which can play important role in changing the properties of their suspensions in fluids.

In order to identify the crystal structures and defects of nanoparticles, the selected area electron diffraction (SAED) technique was used. The SAED patterns of both nanoparticles are shown in Fig.2 which indicates the presence of mono-crystallite particles.

The X-ray diffraction (XRD) analysis of these nanoparticles was also performed by using a computer controlled XRD system of PAN Analytical Powder XRD instrument at an operating rate of 40 KV and 30 mA (Cu-Kα radiation λ=0.1548 nm) in the 2Θ range of 10-80 degrees. The PCPDFWIN- XRD software was used for matching with the standard JCPDS cards. By comparison with the data from JCPDS cards (e.g., #86-0148 for $TiO_2$) the diffraction patterns of these nanoparticles can be indexed to the hexagonal phase. Fig.3 presents the XRD patterns of both nanoparticles. The XRD patterns in Fig. 3(b) showed several strong diffraction peaks which confirm the rutile phase of $TiO_2$. Nevertheless, the diffraction peaks in both patterns indicate good crystallinity of nanoparticles and almost no peaks of impurity were observed confirming the high purity of these nanoparticles. A detailed analysis of the findings of this study will provide better understanding of the role of structural and morphological features of nanoparticles in the anomalous thermophysical and other properties of these new fluids.

**Acknowledgement**

This work was supported by International Research Staff Exchange Scheme of Marie Curie Actions (European FP7)-New Working Fluids based on Natural Refrigerant and Ionic Liquids for Absorption, Refrigeration–NARILAR and by FCT-Portugal to CCMM, FCUL.

**References**

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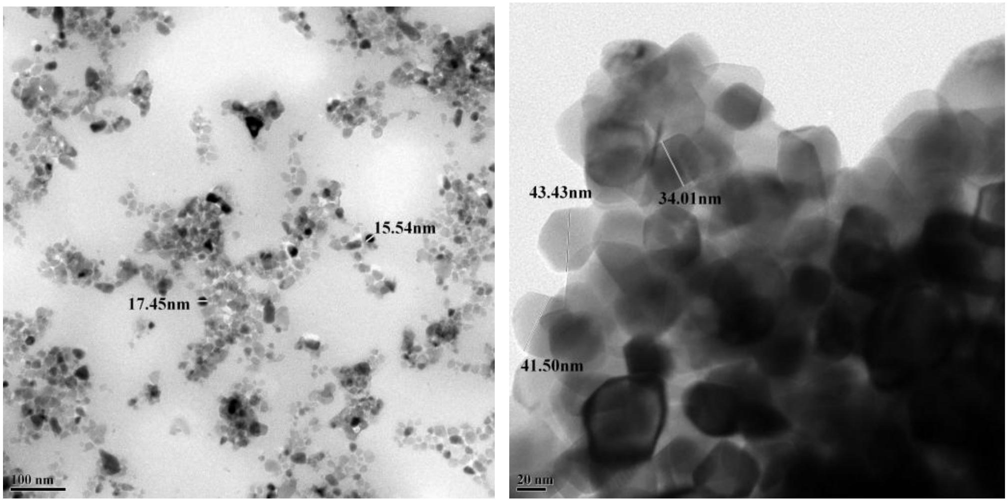
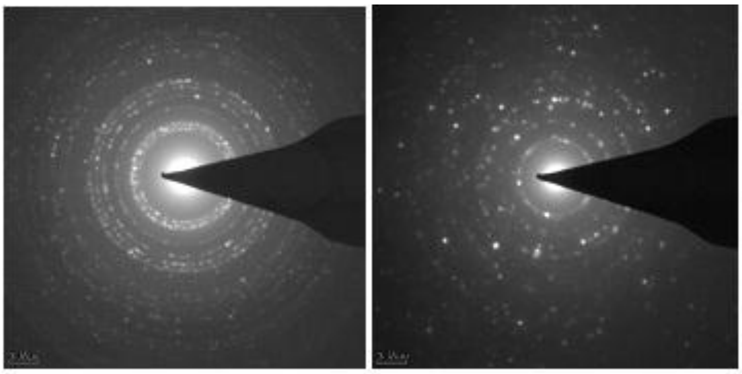
**Figures:**




(a) (b)

**Figure 1:** TEM images of (a) ZnO and (b) $TiO_2$ nanoparticles.



(a) (b)

**Figure 2:** SAED patterns of (a) ZnO and (b) $TiO_2$ nanoparticles.

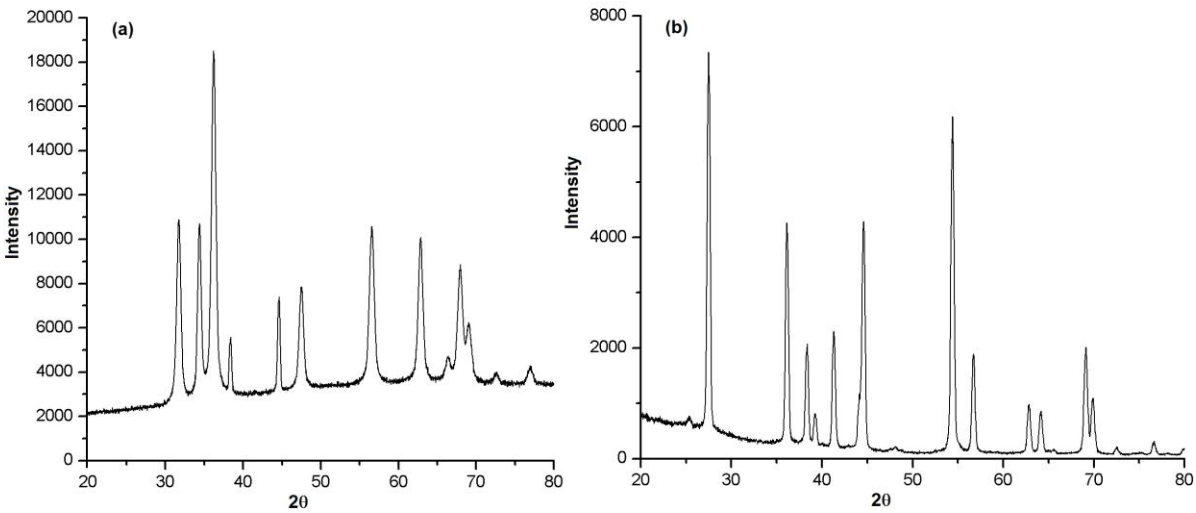



**Figure 3:** XRD patterns of (a) ZnO and (b) $TiO_2$ nanoparticles.