Structural, morphological and vibrational properties of Fe₂O₃ nanoparticles

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Metal oxides are of scientific and technological interest for many decades because of their unique structural, optical, electrical, electronic and magnetic properties. Superior catalytic activity, superparamagnetic behaviour and large specific surface area of nanoparticles makes ferric oxide (Fe₂O₃) an important material for wide variety of applications such as magnetic storage devices, targeted drug delivery, biomedicines, solar energy transformation, ferrofluids, pigments and catalysts [1-2]. Fe₂O₃ is found to exist in different crystalline phase's viz. α -Fe₂O₃, β -Fe₂O₃, γ -Fe₂O₃ and δ -Fe₂O₃ [1]. It has been noticed that α -Fe₂O₃ (hematite) is most stable at lower temperatures than any other form whereas γ -Fe₂O₃ (maghemite) phase is stable for higher temperatures. In the present work, Fe₂O₃ nanoparticles were synthesized using sol-gel reaction method for the optimization of growth parameters. For this, iron nitrate along with solvents (de-ionized (D.I.) water, ethylene glycol) and precursor (gelatin) were dissolved and the mixture heated 100 °C for 1 hour for the preparation of gel. The gel was kept at 150 °C for 2 hours to bring it in powder form. The obtained powder was ground properly and kept at 400 °C for 4 hours to produce crystalline material. The prepared samples were then characterized by using versatile techniques for their structural, morphological and vibrational properties.

Figure 1 shows X-ray diffraction pattern for Ferric oxide nanoparticles. XRD measurements infers that nanoparticles synthesized with DI water and ethylene glycol consists of α - and γ -phase respectively. It is well established that α -phase crystallizes in rhombohedral structure and γ -phase consists of cubic phase. It can be clearly seen from the Fig 1 that 104 peak is dominant in the sample synthesized using Gel

+ DI water whereas reverse is the case for sample synthesized from Gel + EG. The change in the peak intensity ratio is an indication of presence of α -phase.

Figure 1: X-ray diffraction measurement of Fe₂O₃ nanoparticles synthesized using different solvents.

SEM measurements confirms the formation of spherical nanoparticles with slight agglomeration.

Slight agglomeration observed in samples arises due to the magnetic interaction and Vander Waals forces between these nanoparticles. Further, the vibrational characteristics carried out with Raman and FTIR spectroscopic measurements also supports the results of XRD and infers the formation of α - and γ -phase respectively. Based on these results, it is affirmed that synthesis parameters like (solvents and precursors) plays a crucial role in modifying various physical properties as well as for phase of the materials.

References

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