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## Green Synthesis of Fe<sub>3</sub>O<sub>4</sub> Nanoparticles: Structure and Magnetic Properties

Magnetite (Fe<sub>3</sub>O<sub>4</sub>) has drawn interest since its discovery since it is one of the naturally occurring minerals that has importance in paleomagnetic measurements used to study continental drift [1]. The compound is also found in the mantle wedge of subduction zones [1]. Magnetically, Fe<sub>3</sub>O<sub>4</sub> orders ferrimagnetically with a Curie temperature of 850 K having an inverse spinel structure, AB<sub>2</sub>O<sub>4</sub>, with the A site occupied by Fe<sup>3+</sup> and the B sites populated equally by Fe<sup>3+</sup> and Fe<sup>2+</sup> at room temperature [2]. As a result, A site contributes +5  $\mu_B$ , and the B sites contributing -5  $\mu_B$  and +4  $\mu_B$ , respectively, yielding a total spin moment of 4  $\mu_B$  with no orbital moment [2]. Interestingly, Fe<sub>3</sub>O<sub>4</sub> demonstrates a metal-insulator transition, popularly known as the Verwey transition, at a temperature  $T_V = 120$  K, below which two-fold increase in the resistivity occurs [2]. Fe<sub>3</sub>O<sub>4</sub> plays an important role as a catalyst in inorganic processes such as the synthesis of ammonia and in organic methods such as the dehydrogenation of ethyl benzene to styrene [3]. The high demand for magnetic recording media coupled with the possibility of imaging the atomic structure and the electronic properties of the surface made it the potential candidate [3] for this use. Specifically, attention was focused on the study of the surface reconstruction of magnetite and its magnetic properties [3]. The inverse spinel structure is stable and can be retained even by application of pressures up to 10 GPa [4]. As a consequence, the B sites are randomly occupied by Fe<sup>2+</sup> and Fe<sup>3+</sup> even at high pressure. Charge ordering can therefore not be precluded to explain the Verwey transition under high pressure and low temperatures [5]. Looking at the importance of Fe<sub>3</sub>O<sub>4</sub>, the present work aimed at the synthesis of Fe<sub>3</sub>O<sub>4</sub> nanoparticles using a novel green synthesis approach. For the green synthesis, native Aloe arborescens plant extract was used in the co-precipitation method. The average crystallite size was found to be 22.20 nm from the X-ray diffraction (XRD). Temperature and applied field dependent magnetization measurements confirm the retention of ferrimagnetic behavior up to 300 K. To manipulate the magnetic ordering Cr<sup>3+</sup> was substituted at Fe<sup>3+</sup> site. Effect of synthesis method, particle size and Cr doping on crystal structure and magnetism will be discussed in this work.

### References

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### Apply to be considered for a student ; award (Yes / No)?

Yes

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PhD

**Primary authors:** NAGARAJ, Shobana (University of Johannesburg); MOHANTY, PANKAJ (University of

Johanneburg); SHEPPARD, Charles (Department of Physics, University of Johannesburg); PRINSLOO, Aletta (University of Johannesburg)

**Presenter:** NAGARAJ, Shobana (University of Johannesburg)

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