Magnetic phase diagram of nanostructured zinc ferrite

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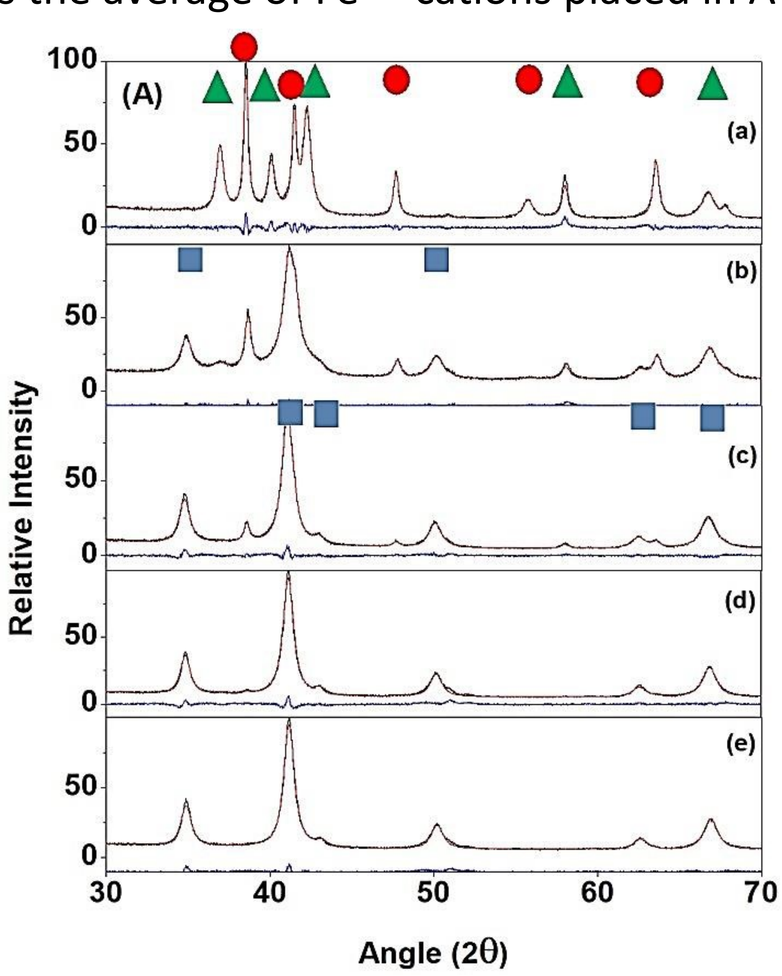
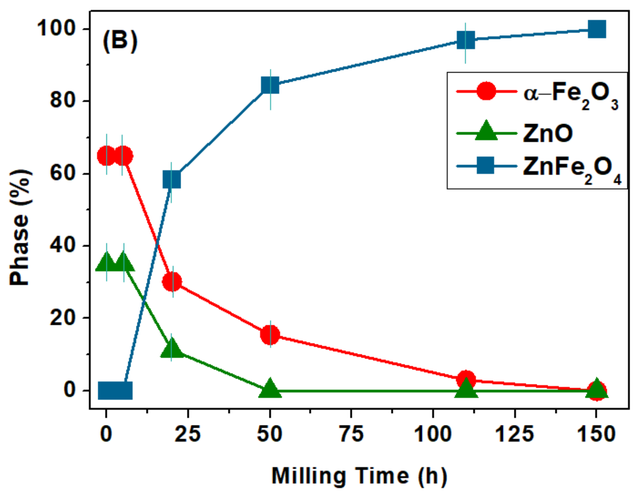
Abstract: Zinc ferrite with a high inversion degree (δ) of 0.57 has been synthesized by mechanical alloying process. The inversion degree (δ) decreases from 0.57 to 0.18 when a thermal annealing is applied from 300°C to 600°C . A magnetic phase diagram as a function of δ can be inferred from the results: 1) for δ <0.25, Antiferromagnetism (AFM), Ferrimagnetism (FiM) and Spin Glass (SG) behaviors coexist, 2) for 0.25< δ <0.5, FiM clusters coalesced and SG behavior vanished remaining only a pure FiM phase with Ms = 3.5 μB. Finally, 3) for δ >0.5, there is a FiM and AFM coexistence

1. Mechanical alloying synthesis. Zn ferrite is synthesized in a single phase with maximum cationic disorder determined by Rietveld.

Inversion parameter (δ) is the average of Fe^{+++} cations placed in A sites.

Hematite and zincite powder are high energy ball milled



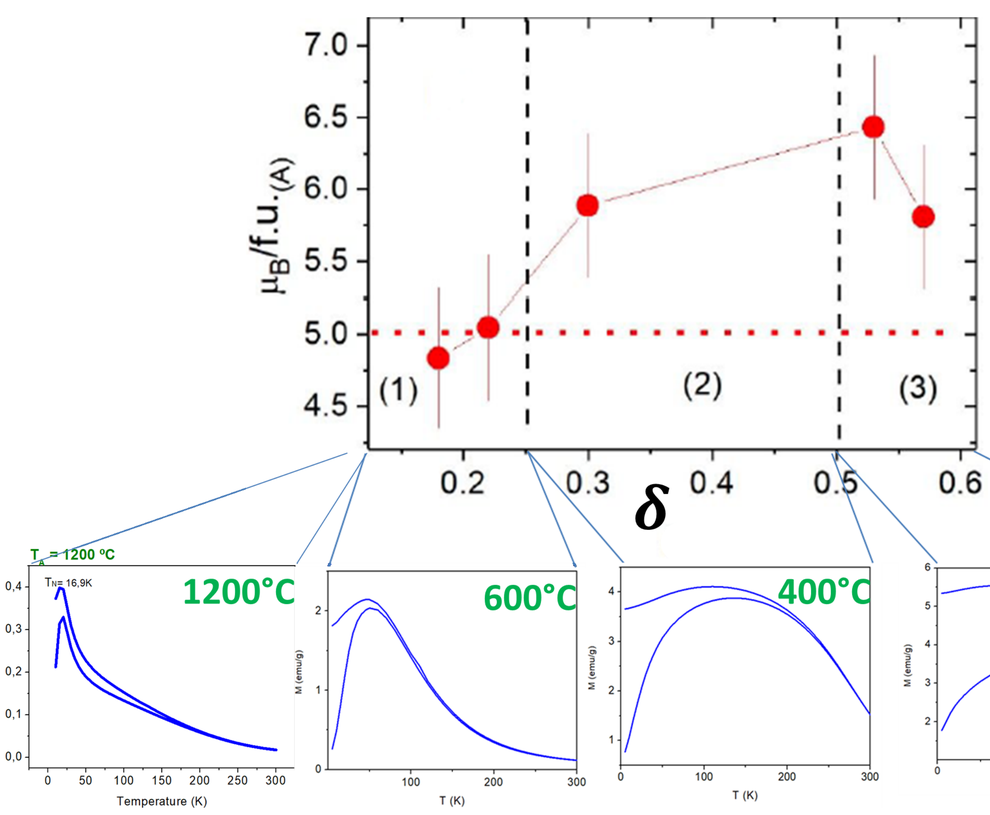


Rietveld analysis

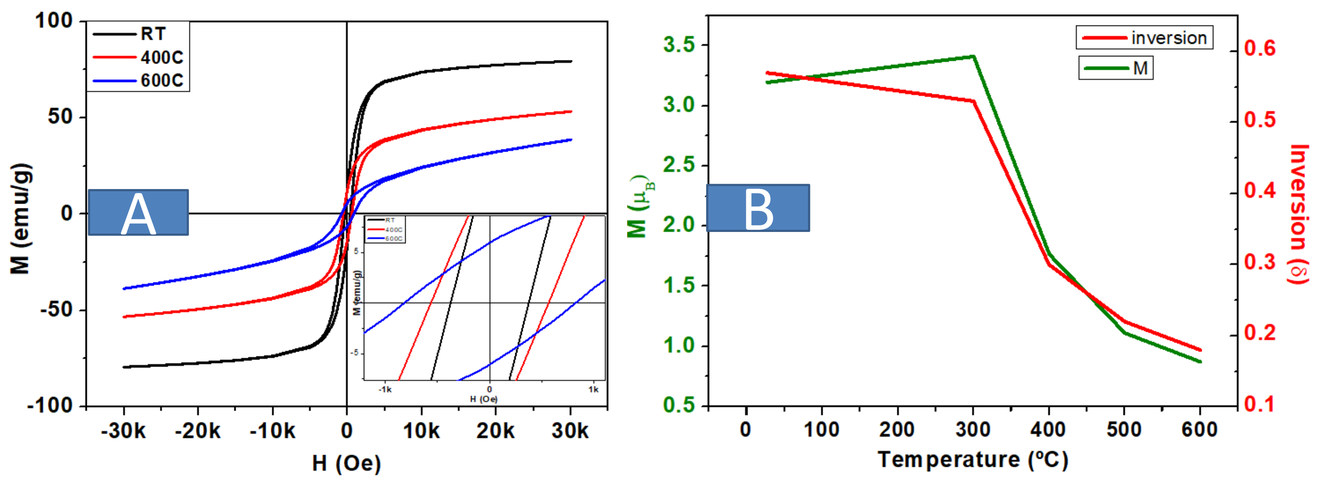
A) XRD patterns as a function of grinding time from a) 5h, b) 20h, c) 50h, d)110h and e) 150h.

B) Phase evolution by milling time

2. Phase magnetic evolution by annealing

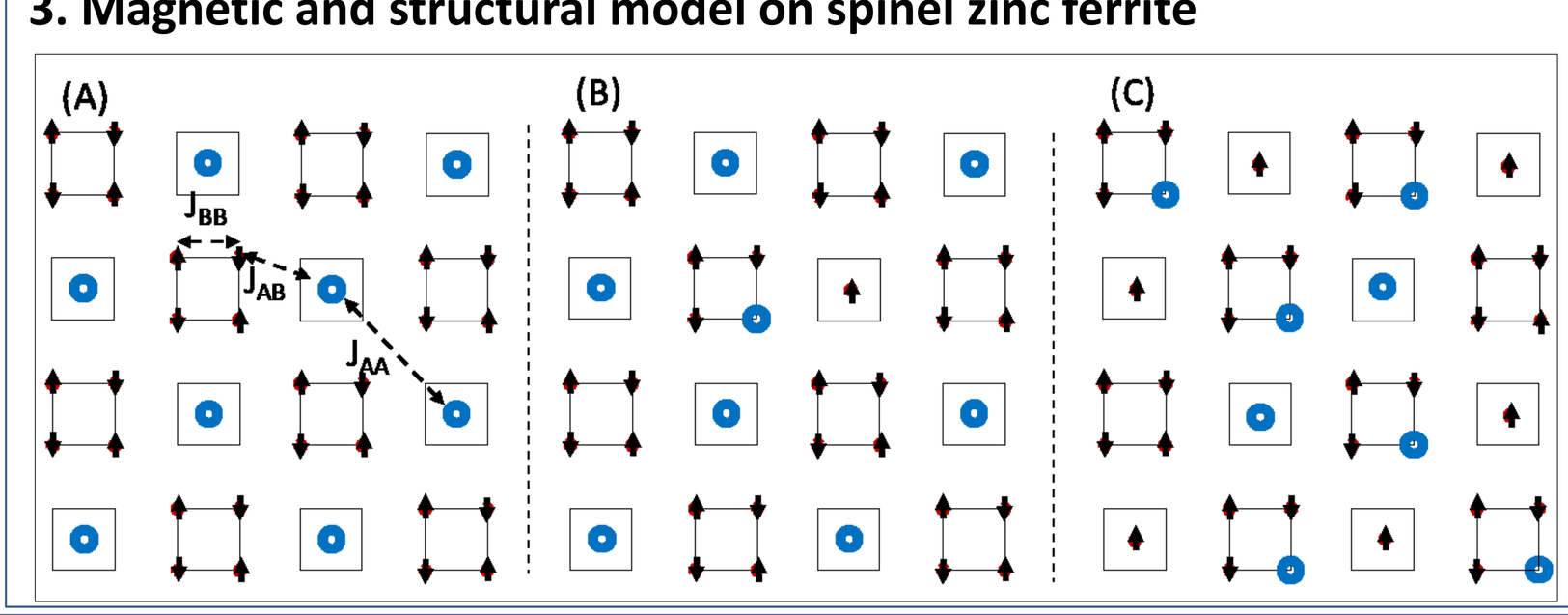


Different magnetic phases depending on **δ** (1) FiM+AFM+SG (2) FiM and (3) FiM+AFM



A) Hysteresis cycle at 5K of as-milled, 400°C and 600°C annealing temperatures samples. **B)** Inversion parameter δ and Ms (5K) as a function of annealing temperature

3. Magnetic and structural model on spinel zinc ferrite



Square network scheme of non-magnetic atoms (blue circles) and magnetic atoms (arrows):

(A) Normal ferrite with the Zn^{2+} and Fe^{3+} atoms at A and B sites, respectively, with AFM interactions.

(B) Zn^{2+} and Fe^{3+} have exchanged their positions, gives place to spin glass behavior.

(C) Exchanged atoms increases giving place to FiM interactions

<u>Conclusions</u>: We present here a systematic study on structural and magnetic order, starting from maximum inversion cationic distribution by mechanical alloying synthesis. This highly disordered ferrite can be partially ordered by annealing at different temperatures, so that its inversion parameter can be slowly decreased. The main result of this work is the determination of different magnetic behaviors as a function of the inversion degree.