Structure and magnetic properties of Mn_2O_3

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Manganese oxide

- Mn^{2+} : the most stable oxidation state ion
- Mn^{3+} : the second

 - at atmosphere for several days, some parts of Mn_2O_3 sample could be MnO

- Two forms of Mn_2O_3

- α-Mn_2O_3 : by heating MnO_2 below 800˚C
- γ-Mn_2O_3 : by complex process

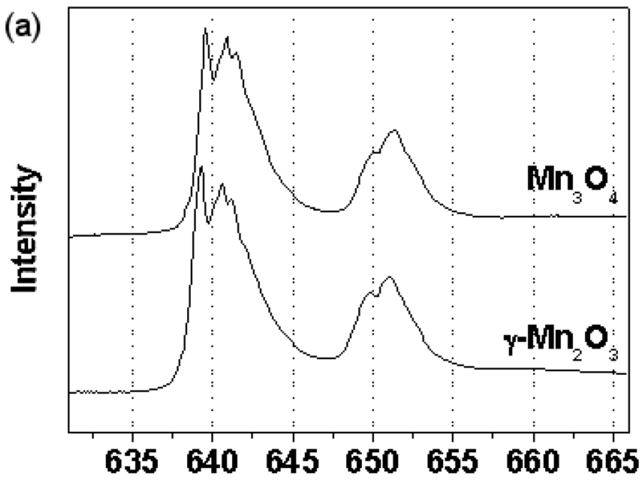
- All oxides and hydroxides of manganese form Mn_3O_4 if heated in air to about 1000˚C

γ-Mn_2O_3

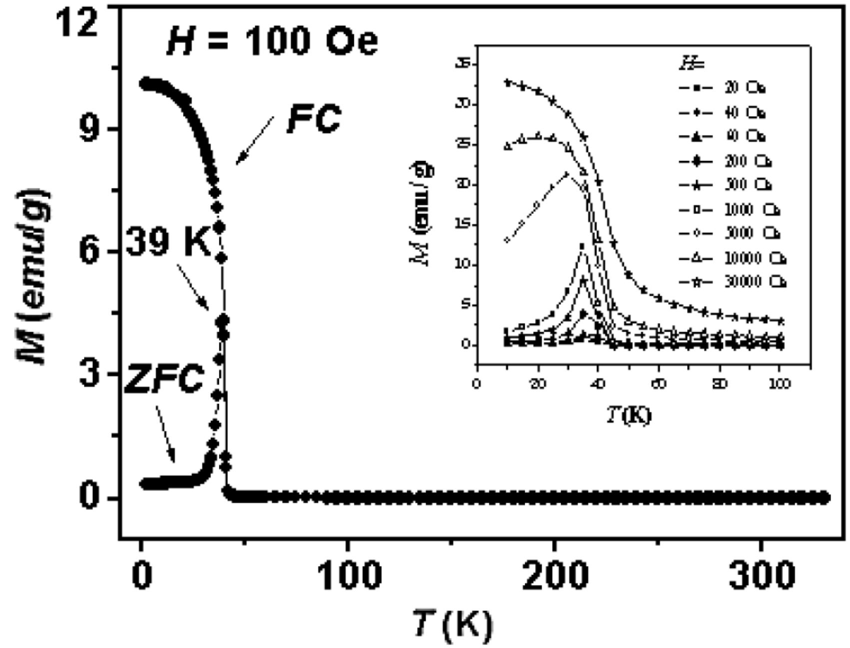
- No exist in natural – most of the Mn_2O_3 is the α phase
- If heated at 500˚C for 48 hours , or been standing at room temperature for 1 year , γ → α phase
- Spinel structure

 - but fewer cation sites are occupied than normal spinel (Mn_3O_4)

γ-Mn_2O_3 nanoparticles



X-ray data
[S. H. Kim et al. 2004]



- zero field cooled(ZFC) and field cooled(FC) magnetization curves
  - Phase transition from ferrimagnetic to paramagnetic at 39K

- ZFC magnetization curves at other applied fields
  - magnetization increases with increasing H
  - transition temperature shift

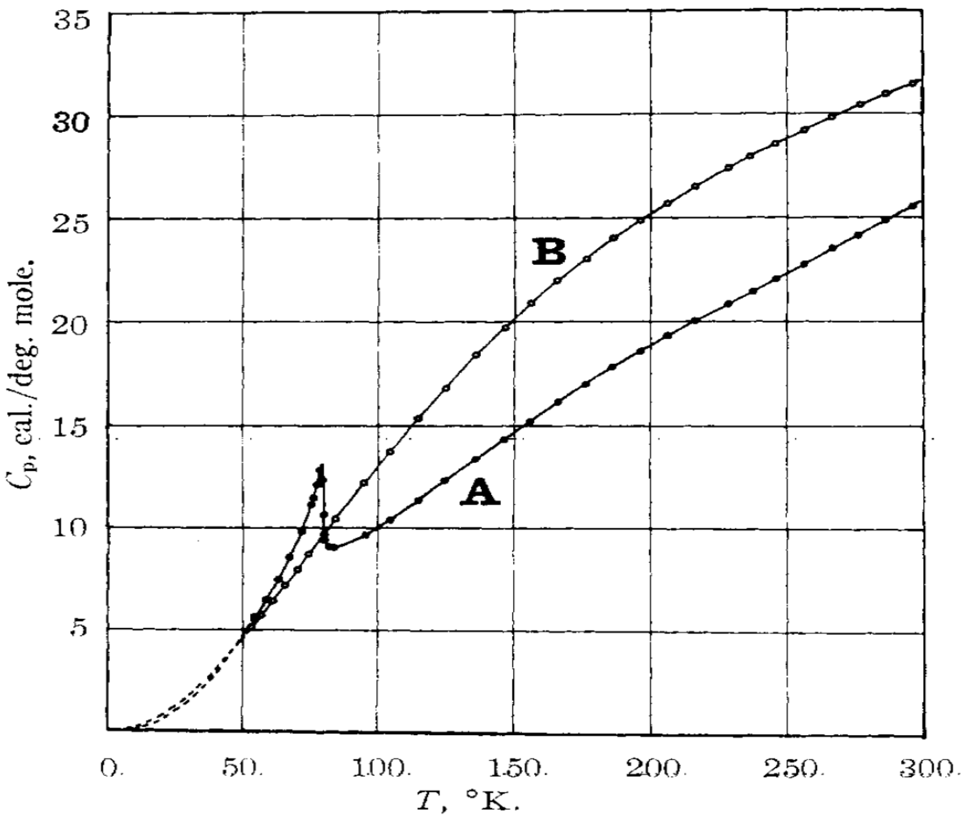
α-Mn_2O_3

- Crystal unit cell : 32 Mn^{3+} ions and 48 O^{2-} ions

- Structural phase transition
- Above 302K : cubic bixbyite [S.Geller 1970]
- Below 302K : orthorombic bixbyite [S.Geller 1970]
  (308K [R.W. Grant, S. Geller 1968])

Bixbyite - manganese iron oxide mineral with formula $(Mn, Fe)_2O_3$

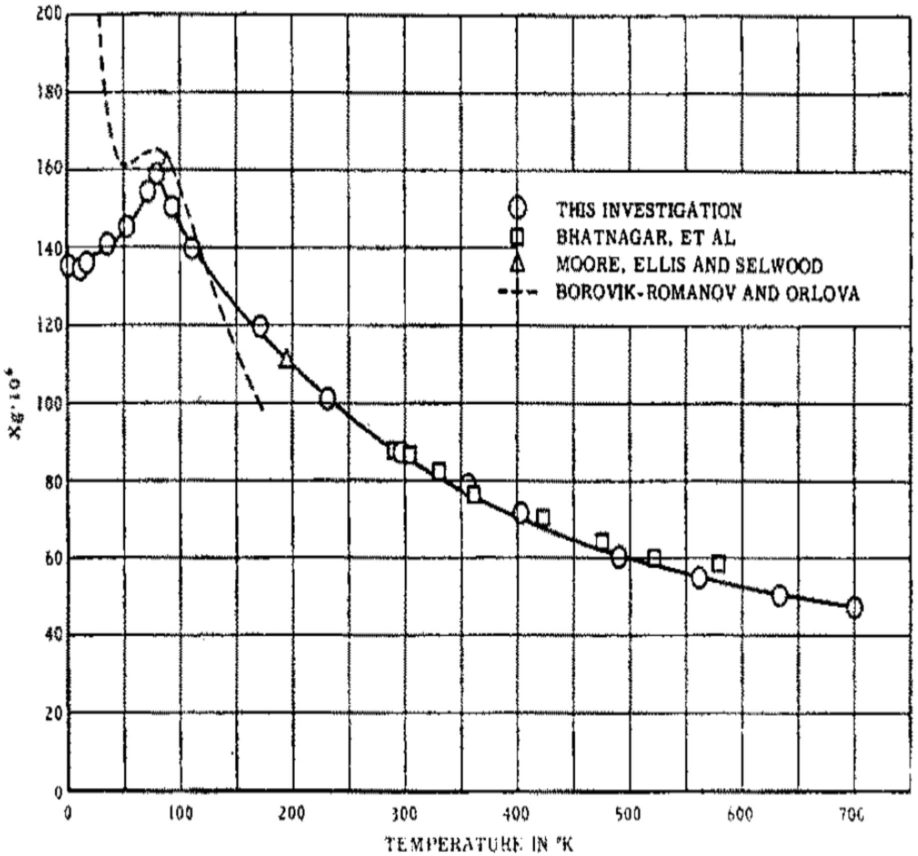
α-Mn_2O_3



Low temperature heat capacity
[E. G. King 1954]

- Peak at 79.4˚K

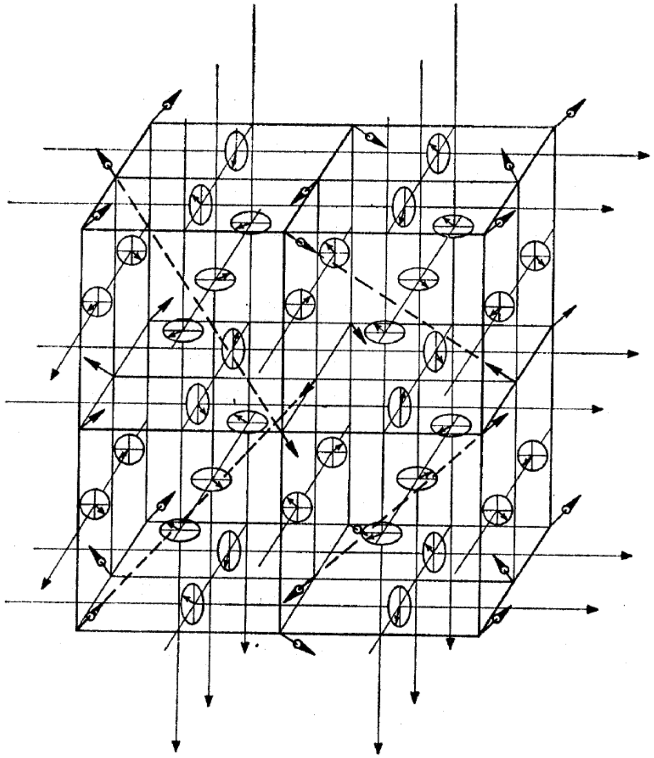
α-Mn_2O_3



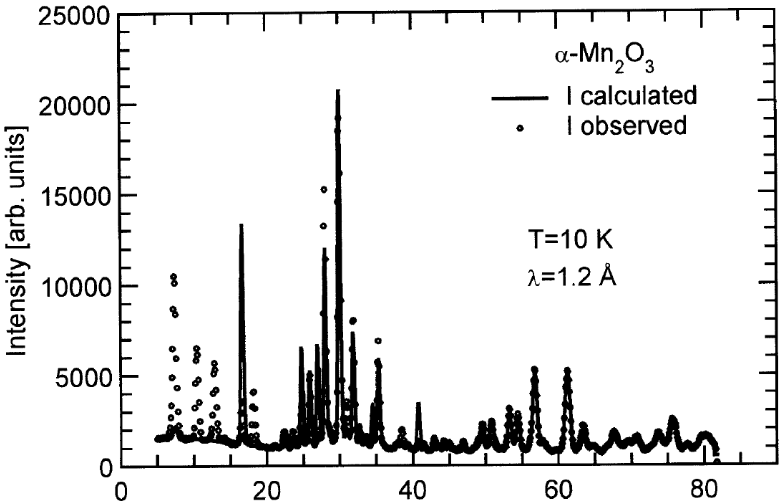
Magnetic susceptibility
[R. G. Meisenheimer and D. L. Cook 1958]

- 4 sets of magnetic susceptibility data
- Antiferromagnetic ordering at about 80K

α-Mn_2O_3



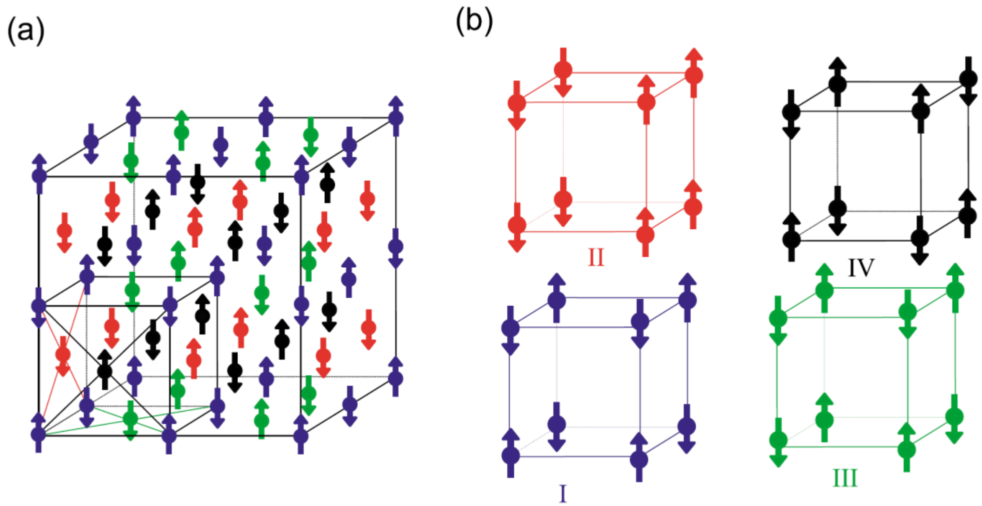
Noncollinear magnetic structure [Grant et al. 1968 and Geller et al. 1971]

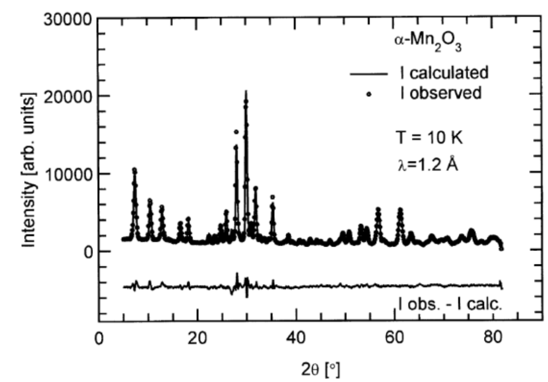


Neutron diffraction pattern at 10K [M. Regulski and R. Schneider et al. 2002]

α-Mn_2O_3

Magnetic structure
[Cable et al. 1957
And M. Regulski, R. Schneider et al
2002]





- Collinear model : all spins are parallel to the z-axis (z-axis is arbitrary)
- 4 sublattice : I (C type arrangement), II (A type), III (E type), IV (G type)
- Magnetic moments for each sublattice : I (3.8~4.0μ_B), II(3.8~4.0 μ_B), III(3.5 ~3.9 μ_B), IV (3.3~3.5 μ_B)

References

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