Structual and Magnetic Properties of Nanocrystallized Trantition-Metal Oxides.

Hiroshi Kira
(2004.8.1～)

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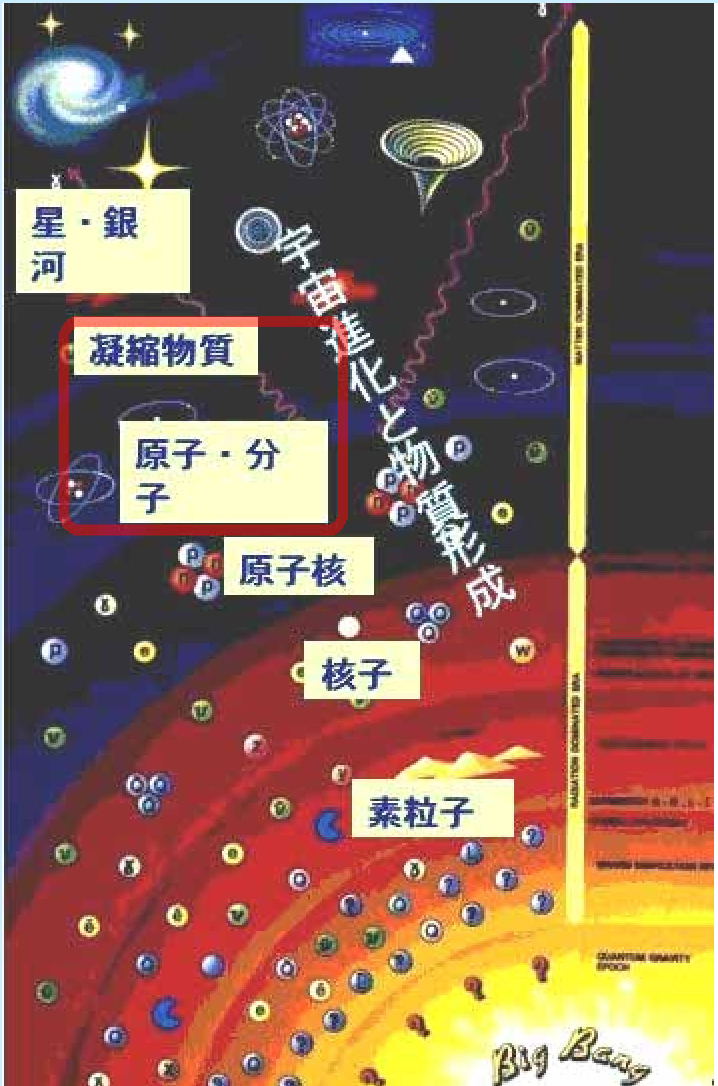
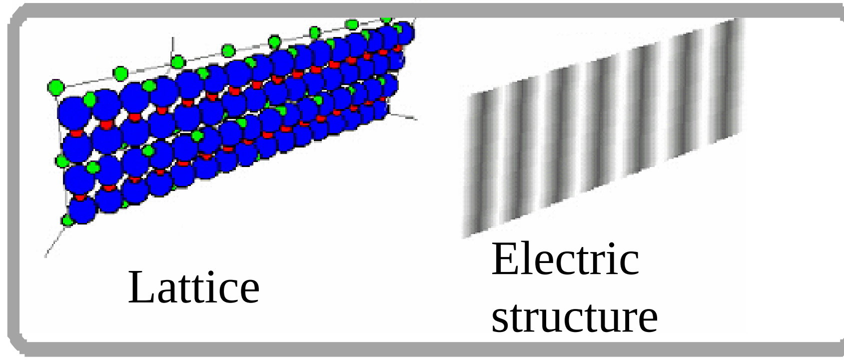
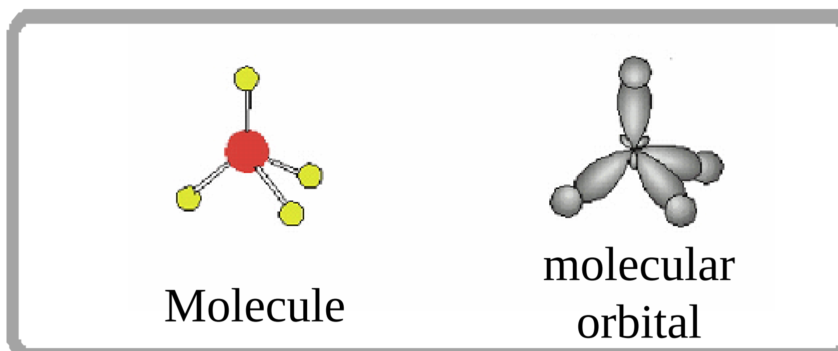
本研究における階層融合

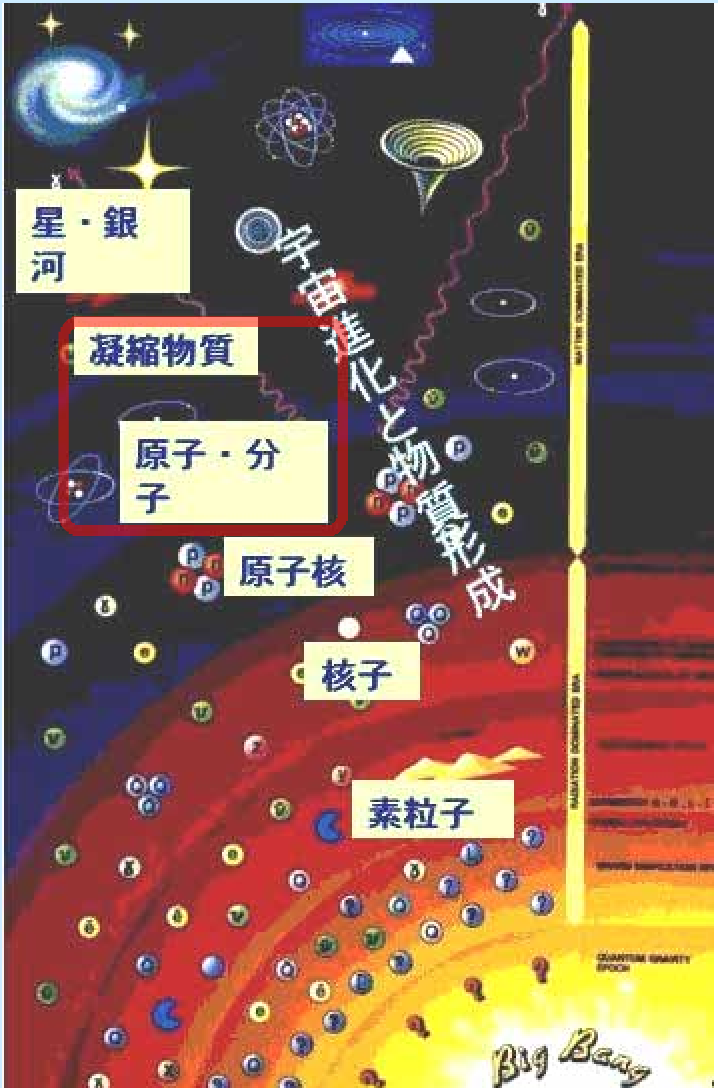


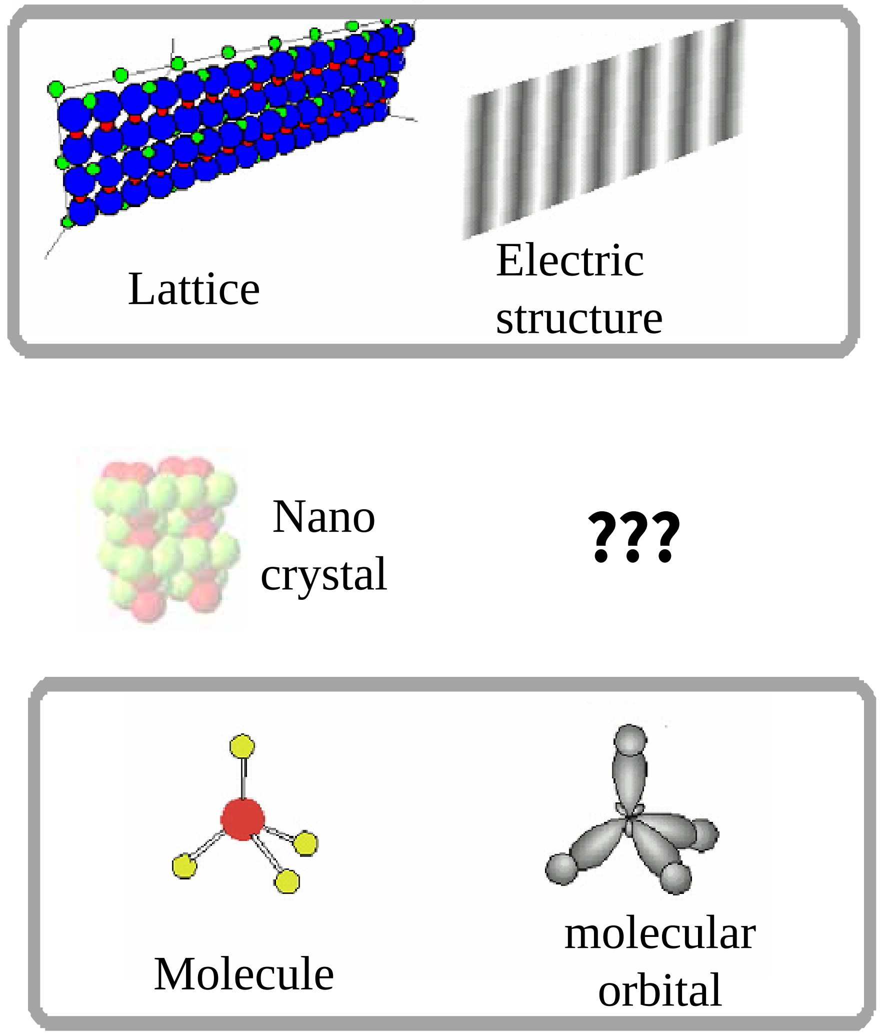




原子･分子と凝縮物質の融合領域

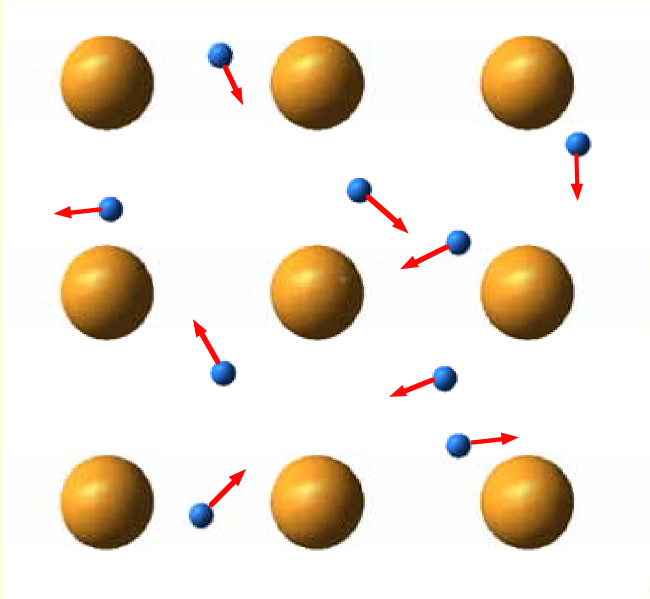
本研究における階層融合

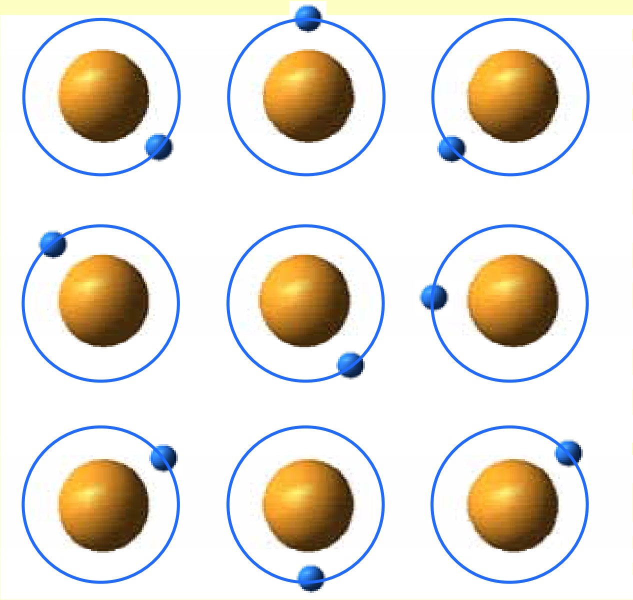




原子・分子と凝縮物質の融合領域

Metal	Strongly Correlated Electron System
Ex) Alkali Metal	Ex) Transition metal oxides



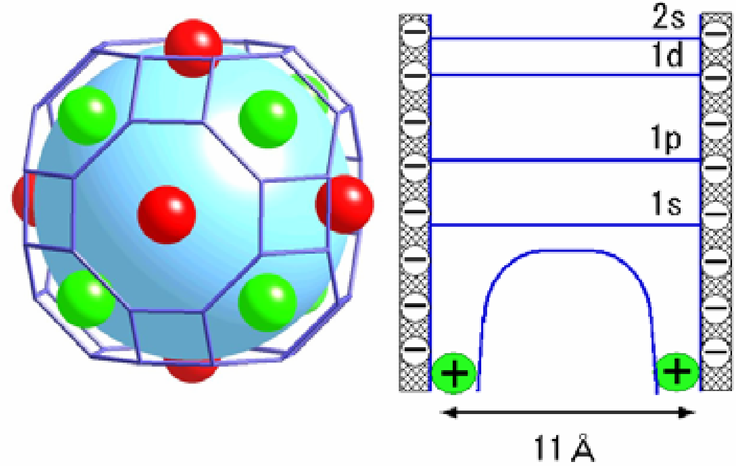


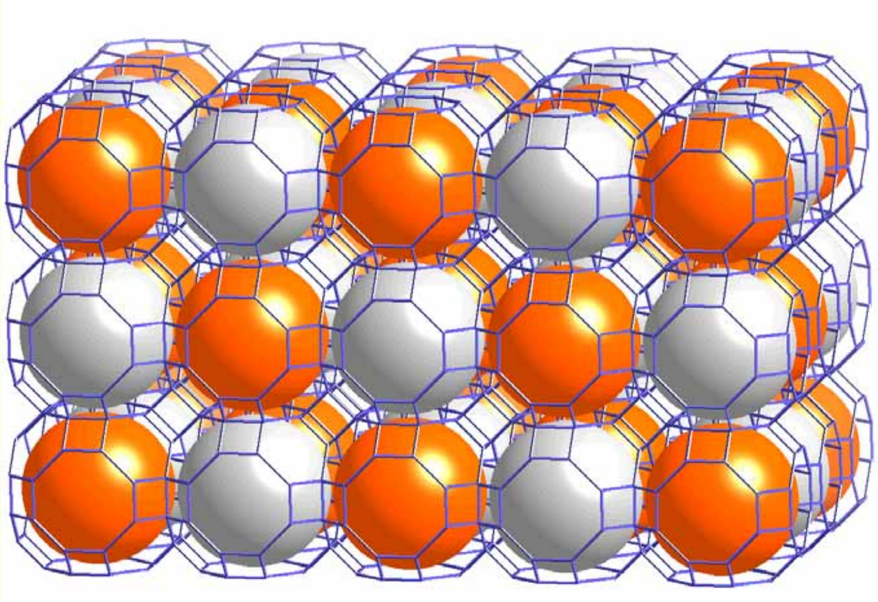
$K_{5.0}/K_{12}$-LTA

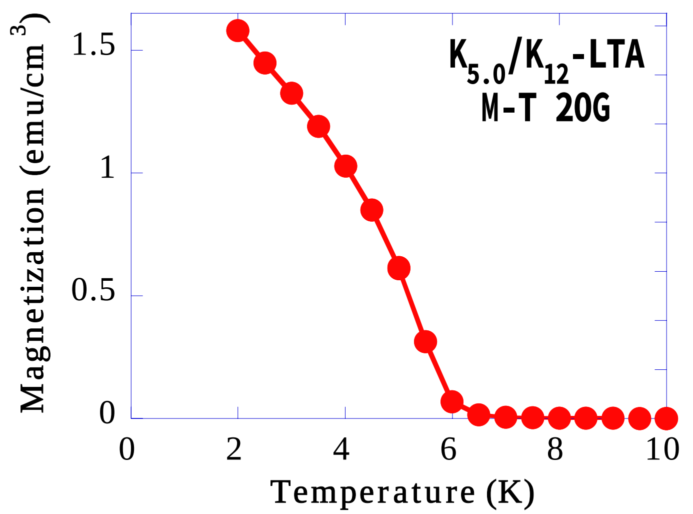
Potassium clusters arranging in simple cubic structure

Tc〜6K Ferromagnetic transition

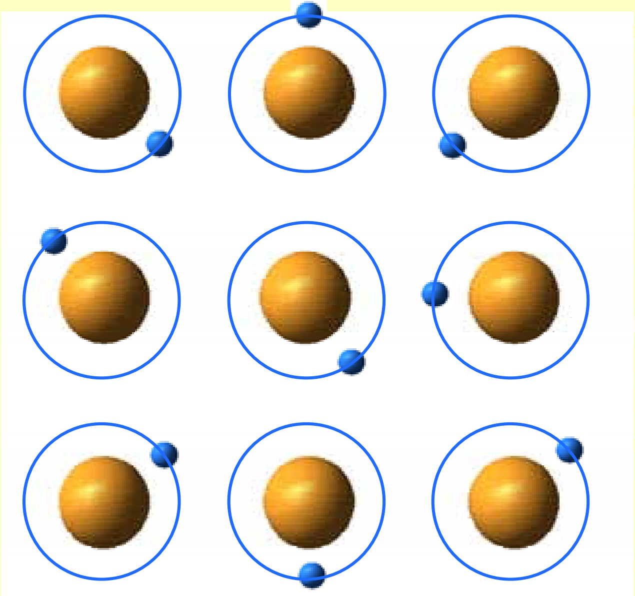
Spherical well potential







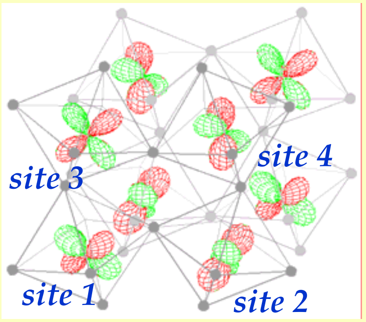
Strongly Correlated Electron System



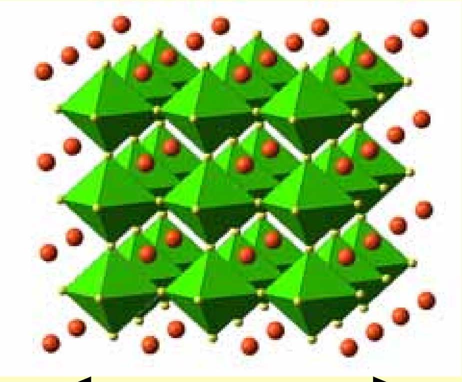
Charge

Spin

Orbital



Nano-crystallized Strongly Correlated Electron System



1〜10nm

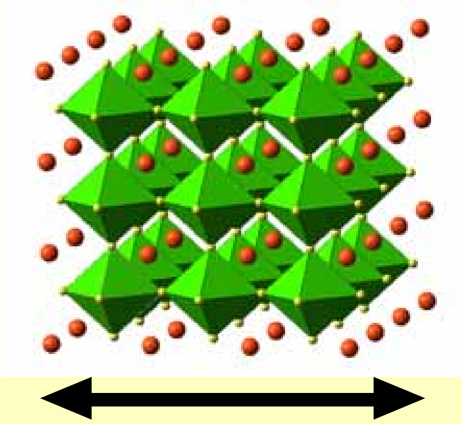
Purpose

Clarify the electronic states of nano-crystallized matter

Problems

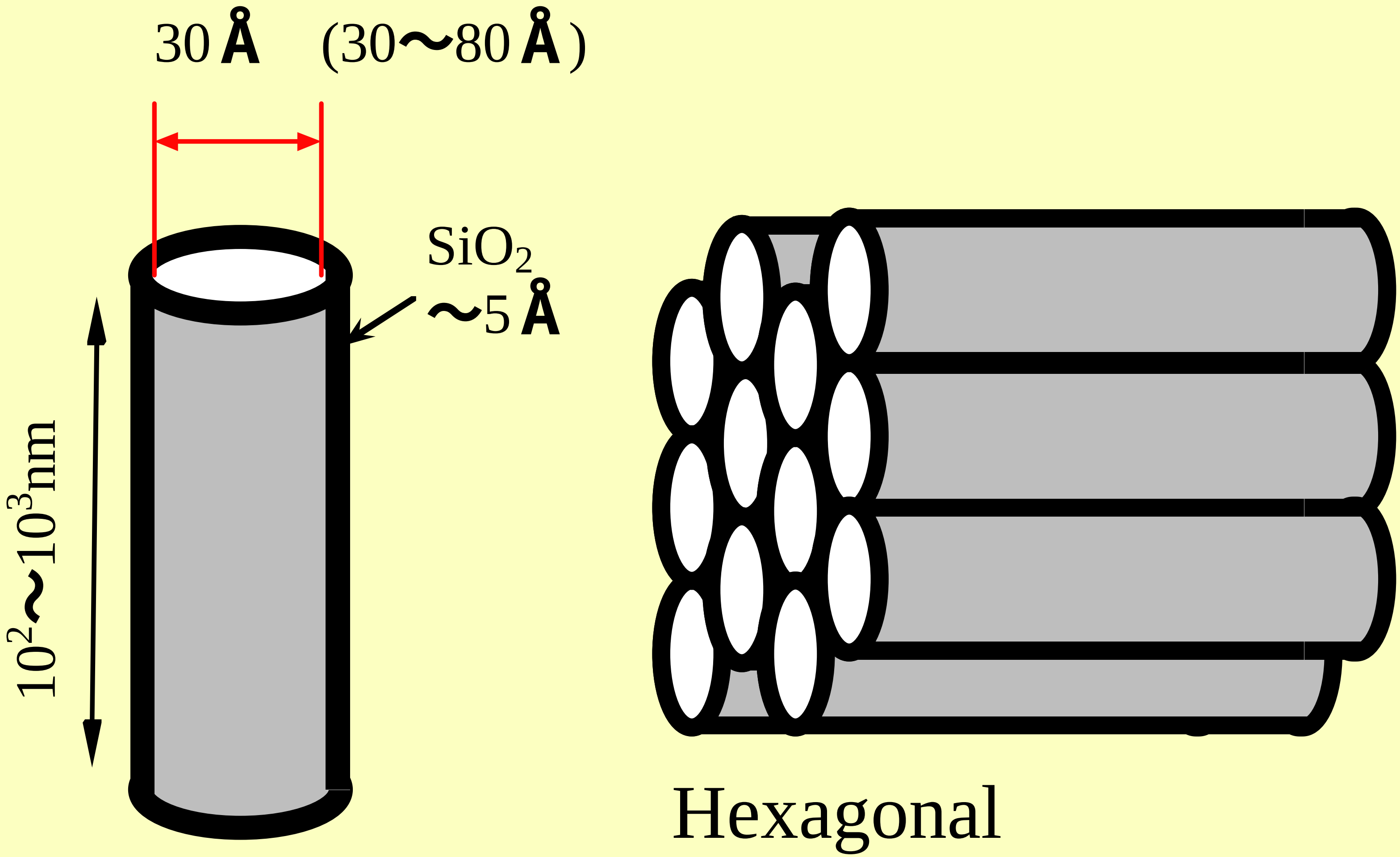
- Synthesis of the nano-crystallized transitional metal oxide
- Stability
- Size-distribution
- Amounts

→MCM-41



1〜10nm

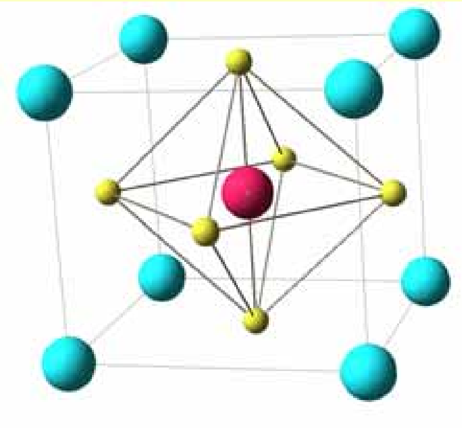
Structure of MCM-41

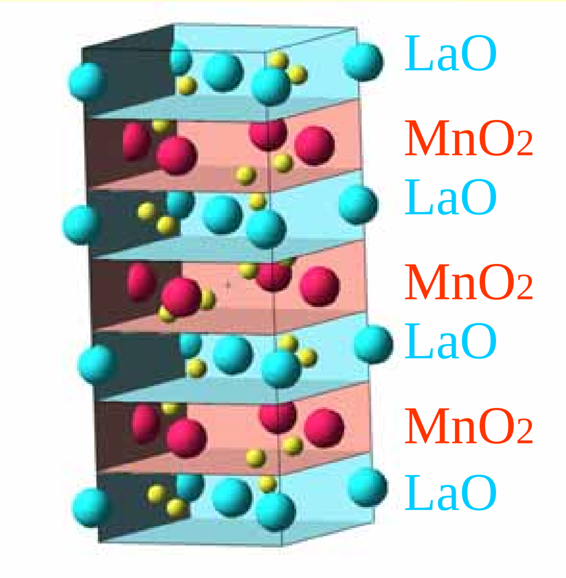


Nanomater sized glass tube

$LaMnO_3$

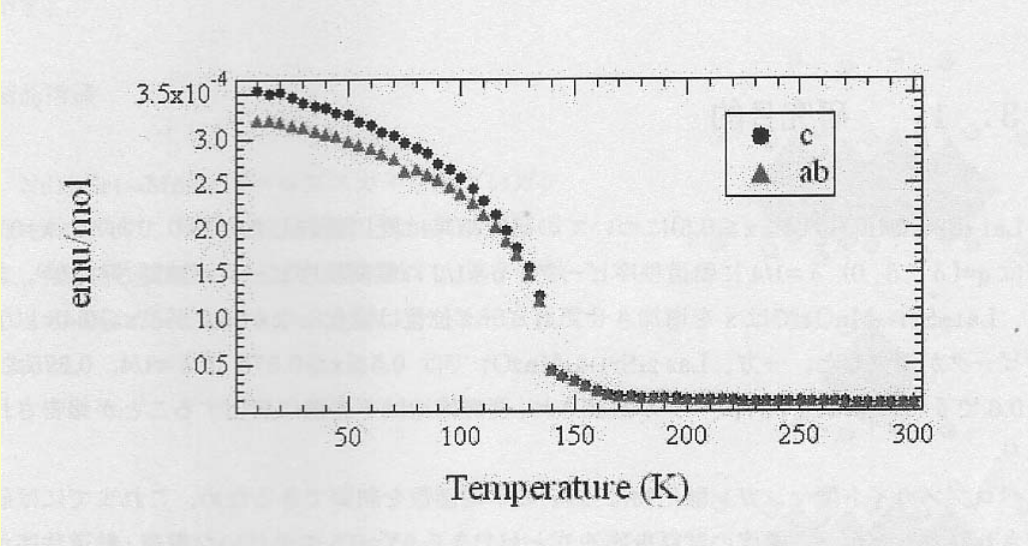
Perovskite Structure





$LaMnO_3$

Canted Antiferromagnet (T_N=141K)



T.Sato, 2003(Tohoku University)

Preparation of LMO/MCM-41

1. MCM-41+ La and Mn Nitrate solution

Dried →

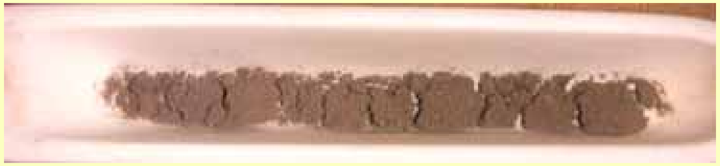
La and Mn nitrate is introduced into 1-d channel of MCM-41

2. Annealing (700°C, 20h, Oxygen atmosphere)

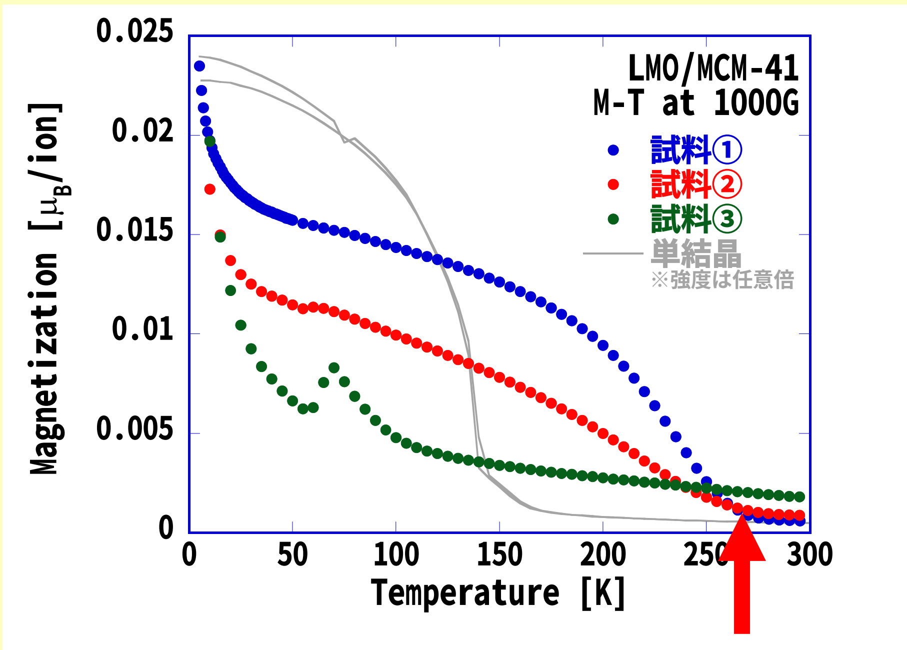
$$La(NO_3)_3 + Mn(NO_3)_2 \rightarrow LaMnO_3 + 5NO_2 + O_2$$

Pristine

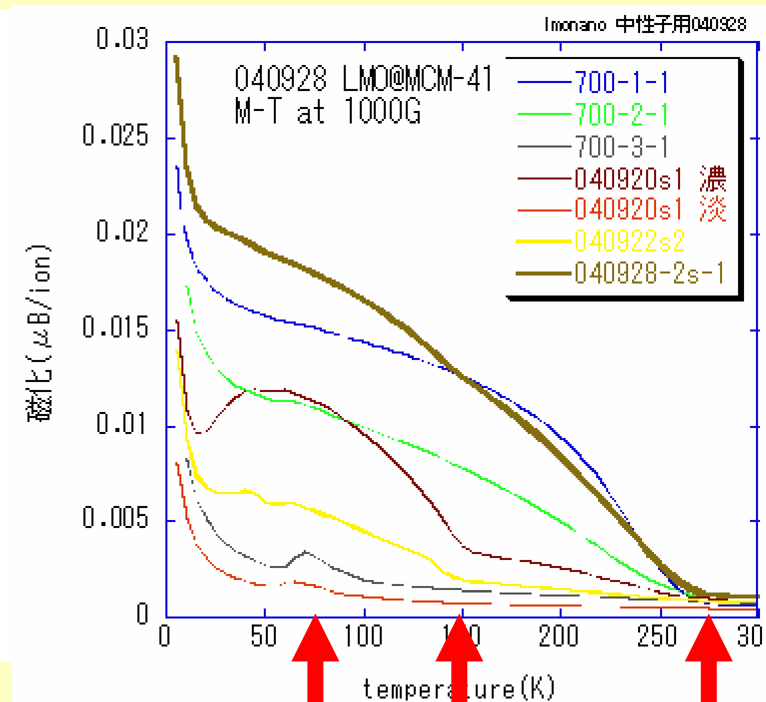
Annealed



Magnetic properties of LMO/MCM-41



Tc



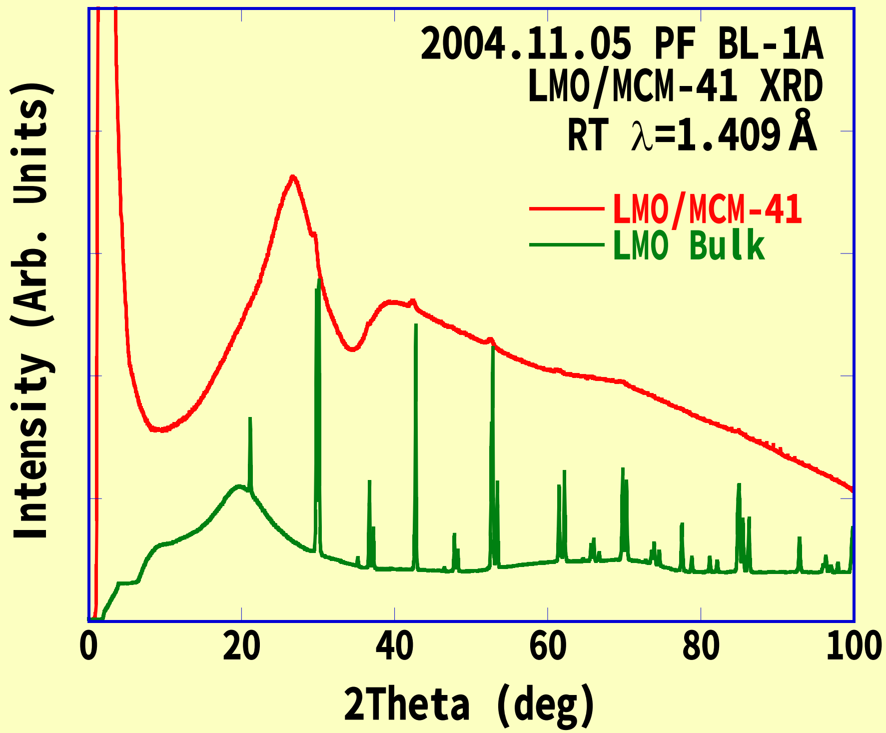
75K **150K** **270K**

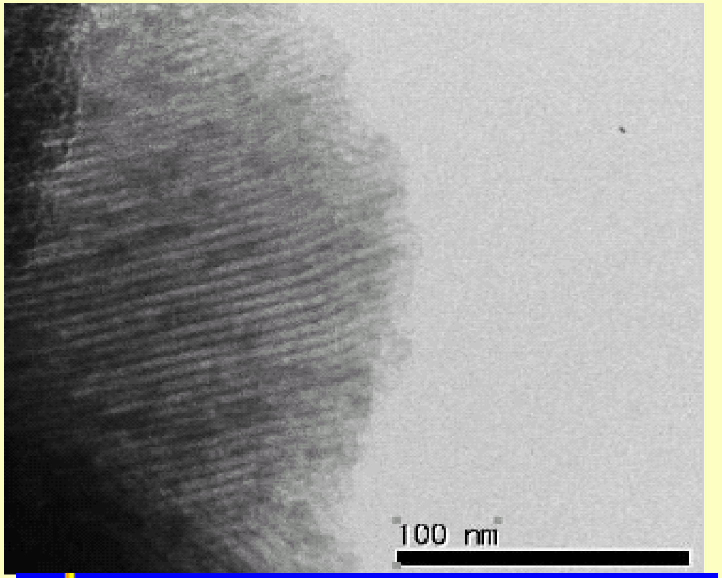
Three Types FM Transitions Tc=75K,150K,270K

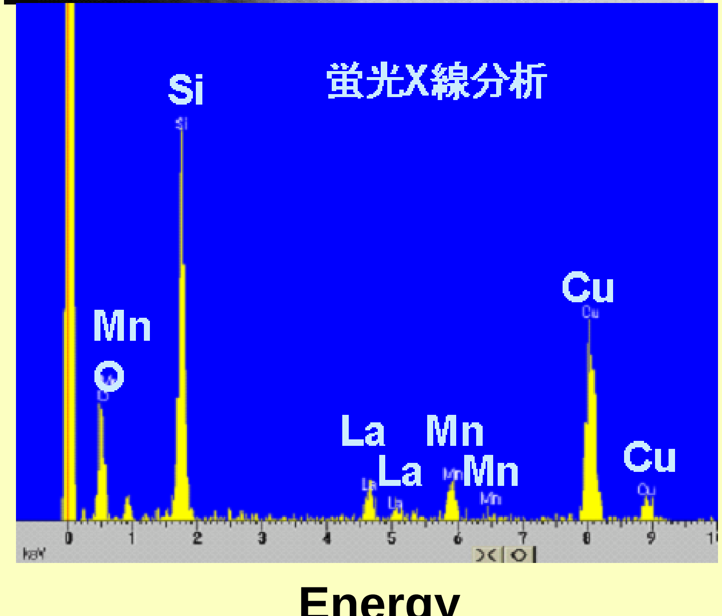
- **Tc = 270 K??**

  $LaMnO_{3+\delta}$: Tc=130K – 160K

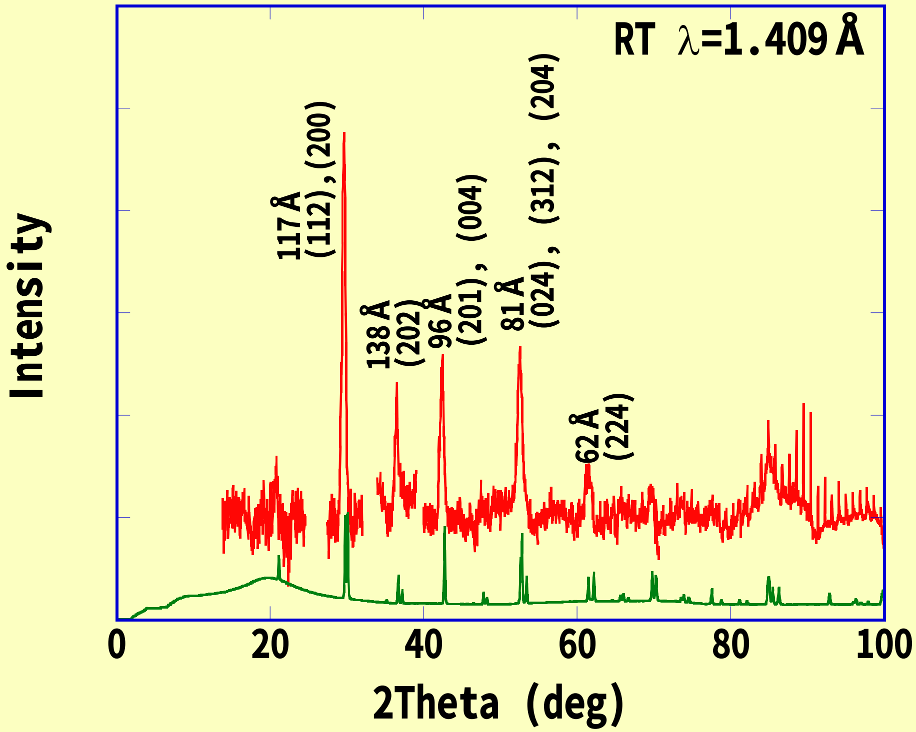
X-Ray Powder Diffraction AND TEM Image

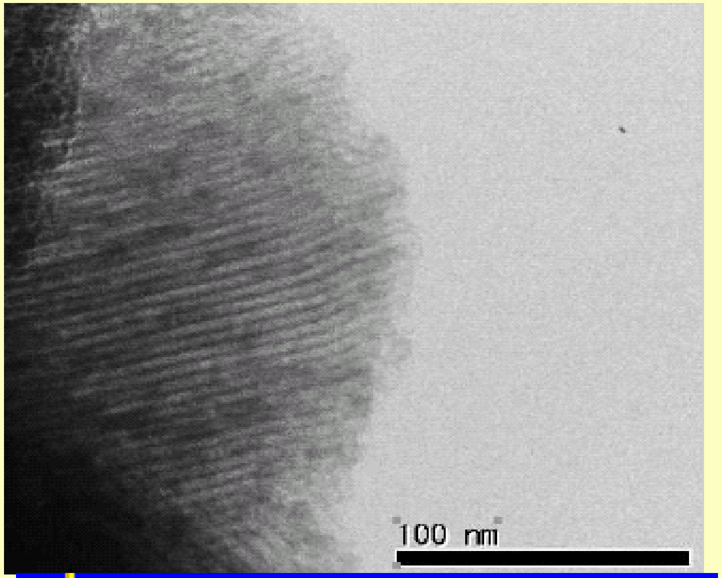


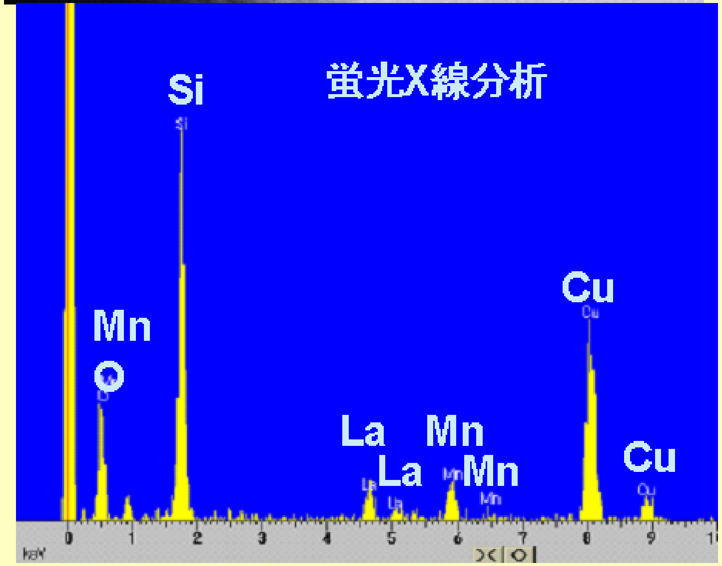




X-Ray Powder Diffraction AND TEM Image







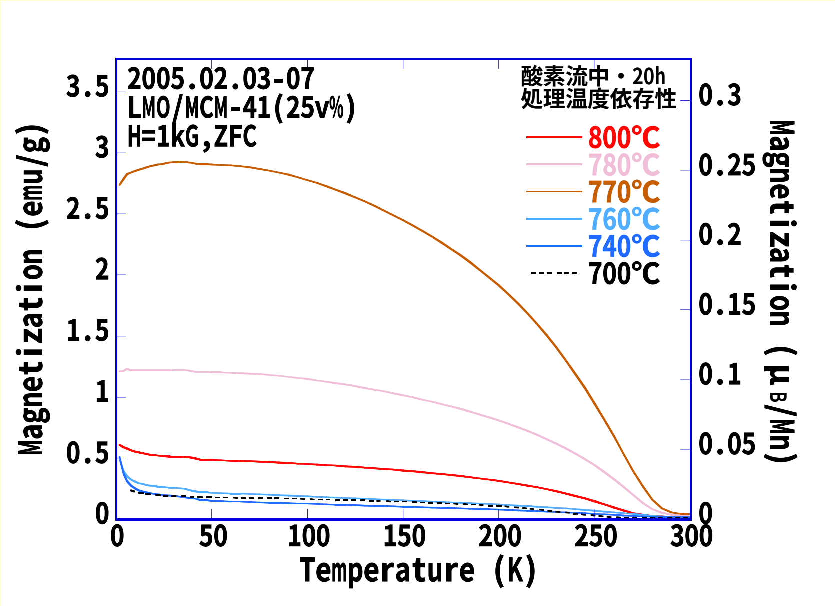
Energy

- **LMO nano crystal**
- **No bulk phase LMO**

→Observed FM transition corresponding to the nano crystal?

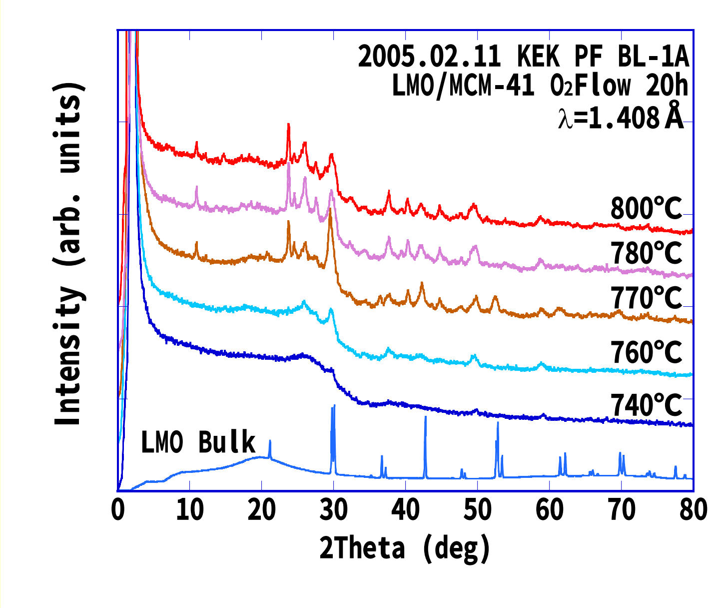
Optimization of the synthetic condition 1

Magnetization



770**℃で最も大きい磁化**

X-Ray Powder Diffraction

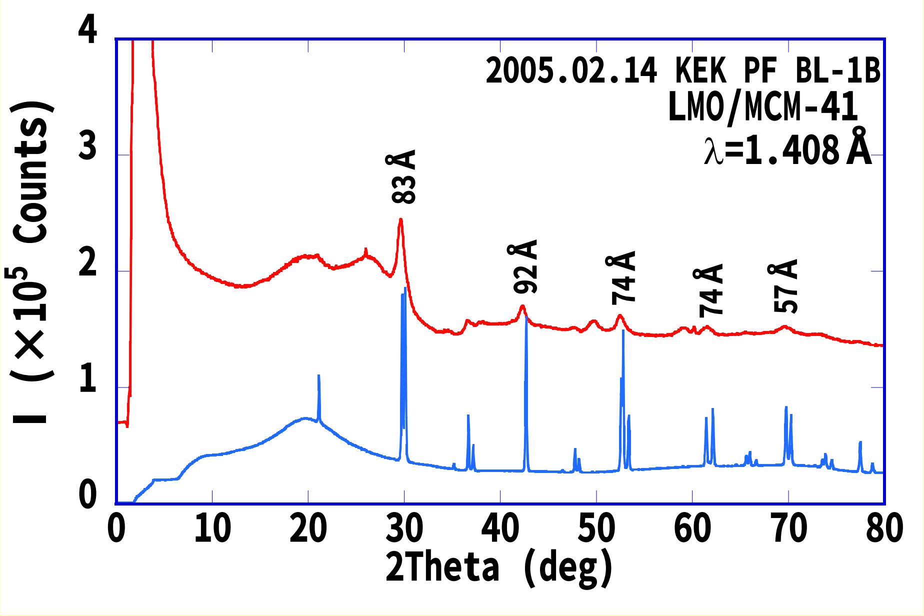


760**℃以上では**$La_2Si_2O_7$

Observed FM transition (Tc=280K)
corresponding to the nano crystal

Optimization of the synthetic condition 2

Annealed at 750℃

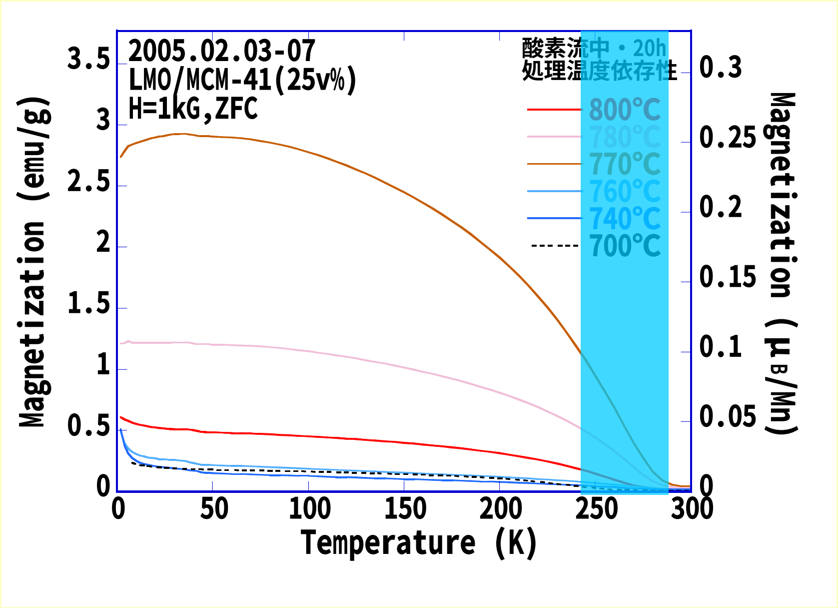


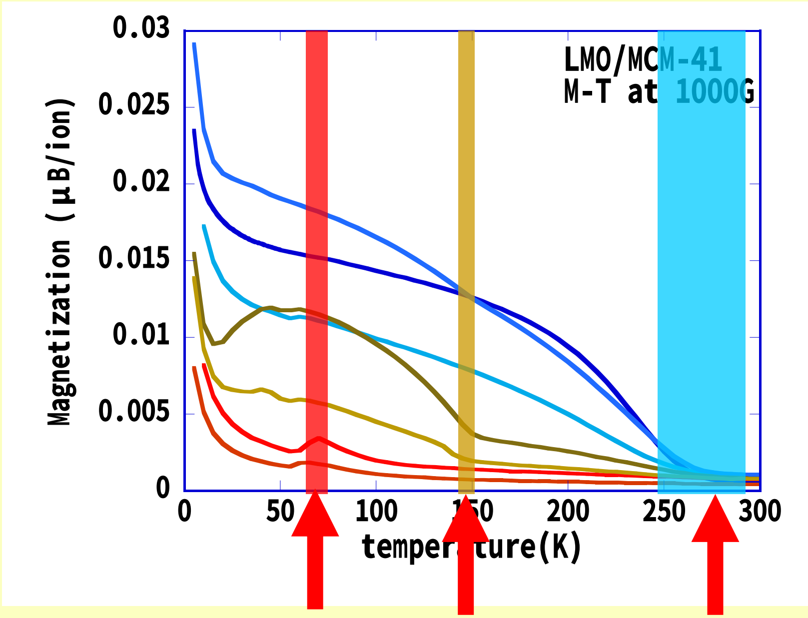
- **Peaks of LMO Nano Crystal**
- **Size of the nano crystal**
  →60～100 Å

Succeeded in developping the method of nano-crystallize the transition metal oxides

Magnetism of LMO/MCM-41

Three types of ferromagnetism

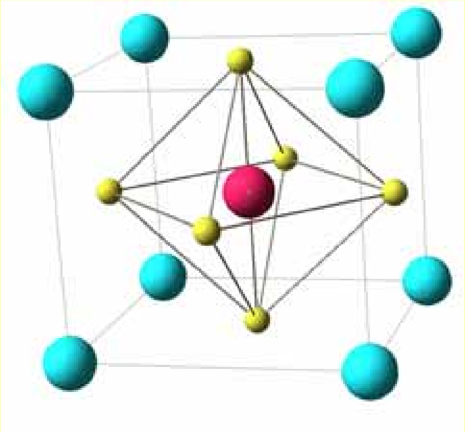




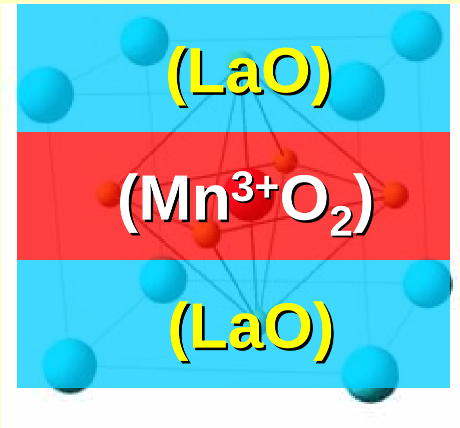
75K 150K 270 ～280K

Three types of LMO nano crystals

Electronic states of nano crystals in LMO/MCM-41



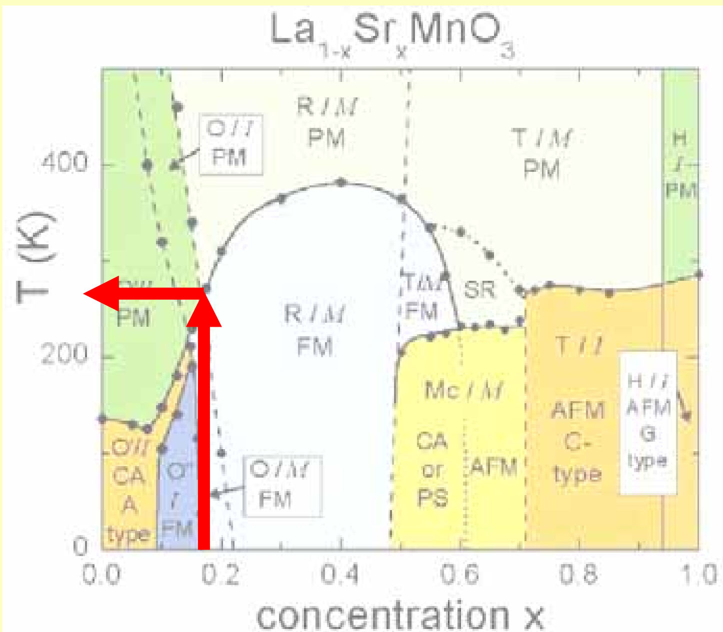
Magnetism of LMO/MCM-41



+1

-1

+1



Amounts of introduced hole

~30 Å

10-15 Layers

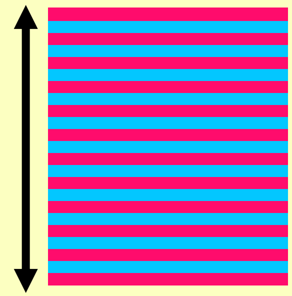
? ? ? ?

Nano-crystallized $LaMnO_3$

Limited Size

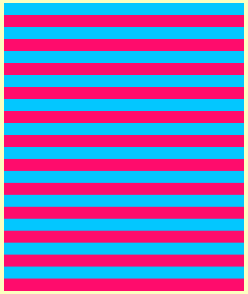
↓

Carrier dope



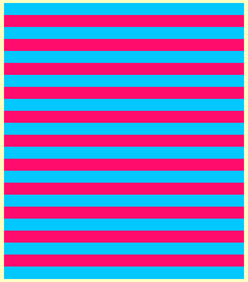
1. T_C = 270 K

δ = 0.1 – 0.2
hole dope



2. T_N = 150 K

δ = 0



3. T_N = 75 K

δ = 0.1 – 0.2
carrier dope

TiO_2 / MCM-41

TiO_2 Cataryst

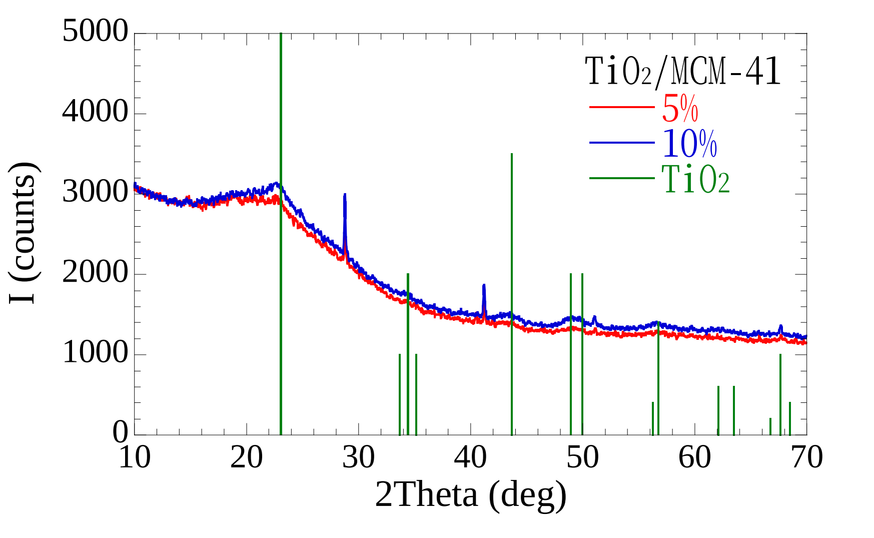
works with UV light

Nanocrystal TiO2

Visible light??

X-ray powder diffraction

TiO_2 nano clusters realized



Conclusion

Purpose

Clarify the electronic states of nano-crystallized matter

Results

Succeeded in preparation of $LaMnO_3$nano crystals

Succeeded in developping the method of nano-crystallize the transition metal oxides

high Tc of FM Transition in $LaMnO_3$/MCM-41

Size effects acts the effective charge transfer

TiO_2/MCM-41 nano crystals

MnO_2/MCM-41