

Title: Structural, Electronic, Magnetic, and Thermal Properties of  $\text{Pb}_{2-x}\text{La}_x\text{CrO}_5$

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Abstract:  $\text{Pb}_2\text{CrO}_5$  have received considerable interests due to their potentials applications in UV radiation measuring devices, visible and UV light photodetectors. In this research we are examining the structural, electronic, magnetic, and thermal properties of polycrystalline  $\text{Pb}_{2-x}\text{La}_x\text{CrO}_5$ . Samples have been prepared using a solid state solution technique. The temperature dependent magnetic measurements reveal a transition in the  $\text{Pb}_2\text{CrO}_5$  and La doped samples near 300 K. To understand the possible origin of such transition, we measured thermal properties using Differential Scanning Calorimetry (DSC) technique. These results reveal an endothermic transition close to 285 K in the parent sample and in La doped sample. We have also measured the temperature dependent resistance in 300K-900K range.

# Structural, electrical, magnetic, and thermal properties of $\text{Pb}_{2-x}\text{La}_x\text{CrO}_5$

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# Outline

- Introduction
- Sample preparation
- Structural properties
- Electrical properties
- Magnetic properties
- Thermal properties
- Concluding remarks

# Interest in $\text{Pb}_2\text{CrO}_5$

## Optical properties

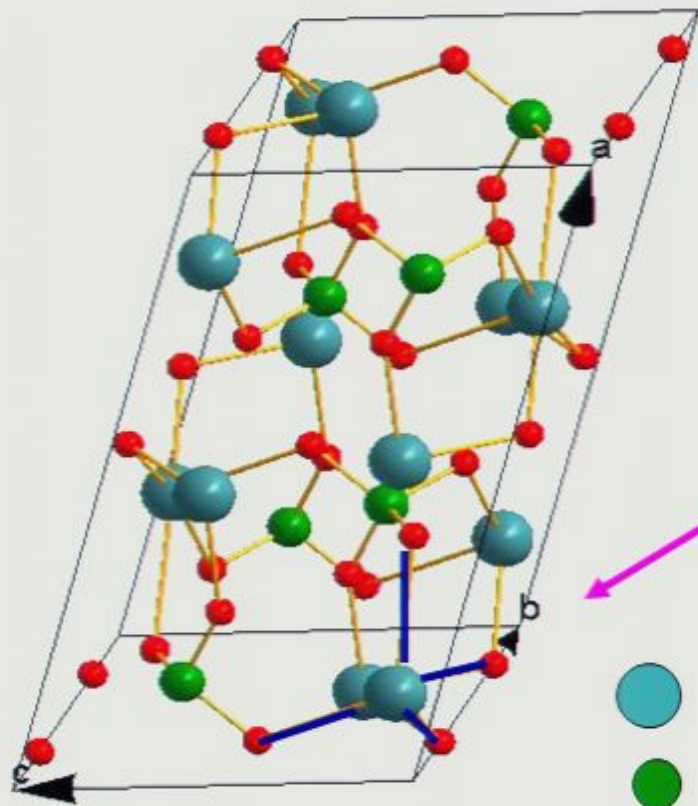
- o Potential candidates as photo detectors and dosimeters
- o Optical band gap  $E_g = 2.3\text{-}2.4\text{ eV}$

Toda et al, J. Appl. Phys. **57** (1985) 5325;  
*ibid* **38** (1985) 103; *ibid* **18** (1999) 689

## Our motivation & objective

To study the impact of La-doping on the **magnetic** and **electrical** properties of  $\text{Pb}_2\text{CrO}_5$ .

# Crystal structure



- Chromium
- Lead
- Oxygen

- Monoclinic,  $C2/m$
- $Z = 4$
- $CrO_4$  tetrahedron

$a = 14.018 \text{ \AA}$   
 $b = 5.683 \text{ \AA}$   
 $c = 7.143 \text{ \AA}$   
 $\beta = 115.23^\circ$   
 $V = 514.8 \text{ \AA}^3$



# Sample Preparation

Dissolved  $\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$   
in distilled  $\text{H}_2\text{O}$

Added  $\text{PbO} + \text{La}_2\text{O}_3$  in  
appropriate amount

500°C for 24 hours

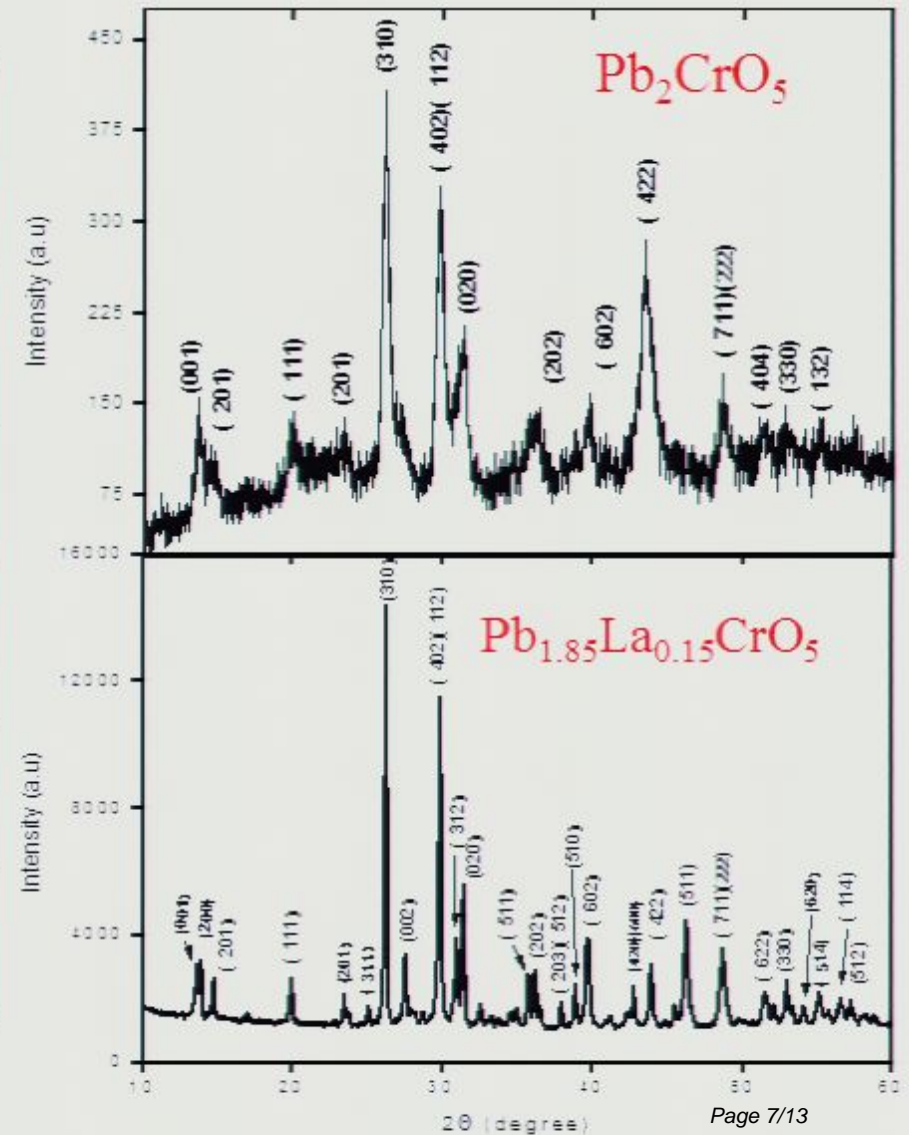
Press pellets

And final sintering at 650 °C for 72 hours



# Structural properties

Cell parameters	$\text{Pb}_2\text{CrO}_5$	$\text{Pb}_{1.85}\text{La}_{0.15}\text{CrO}_5$
a (Å)	13.972	13.898
b (Å)	5.675	5.775
c (Å)	7.164	7.172
$\beta$ (°)	115.278	114.638
V (Å <sup>3</sup> )	513.68	523.16

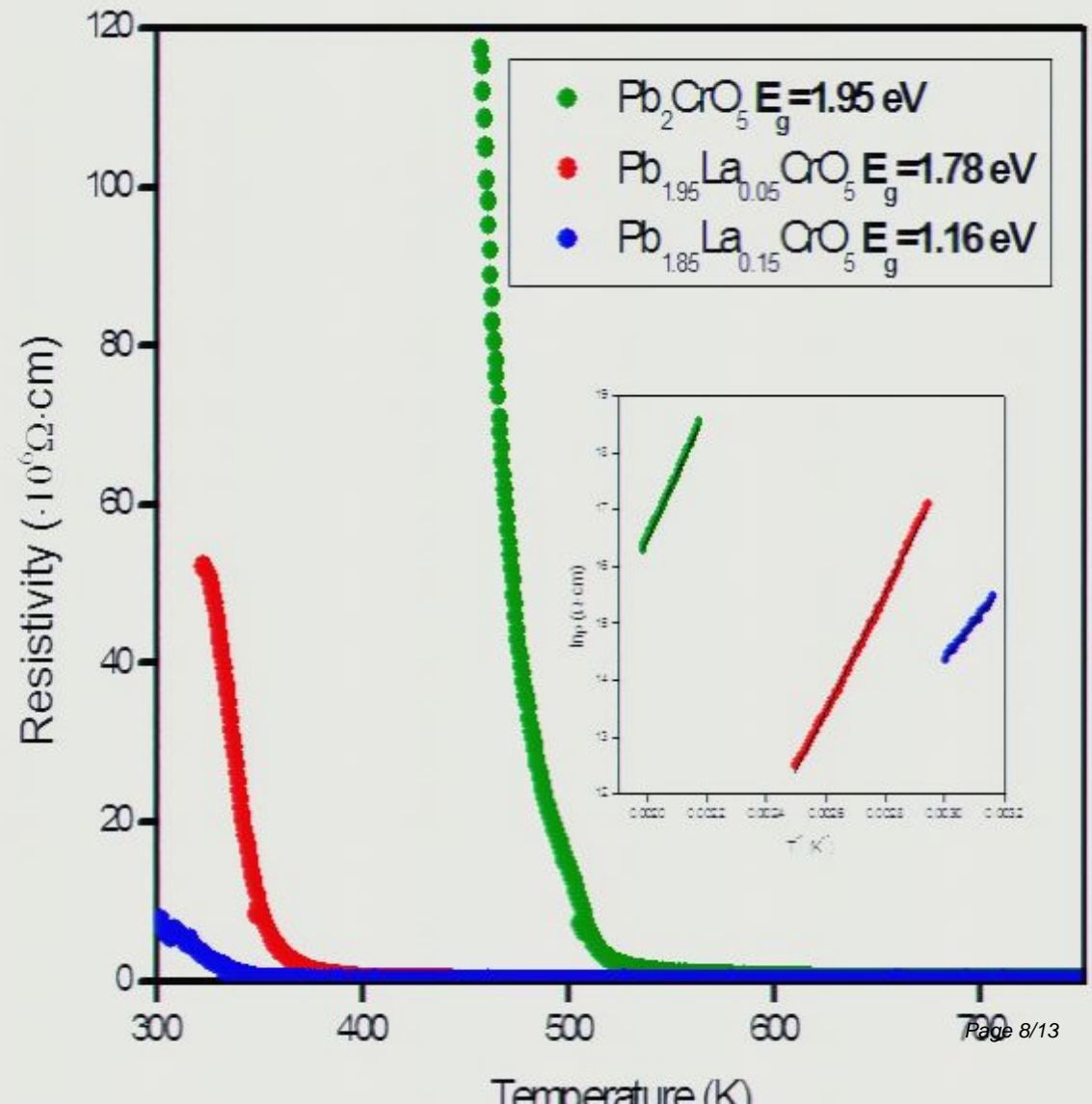


# Temperature dependence electrical properties

Doping with  $\text{La}^{3+}$  at  $\text{Pb}^{2+}$  sites causes excess of electrons

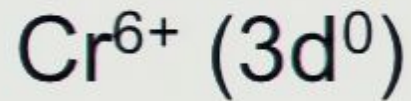
- All samples exhibit semiconductor behavior
- Doping of  $\text{La}^{3+}$  at  $\text{Pb}^{2+}$  sites reduces drastically the band gap

$$\rho = \rho_0 e^{\frac{E_g}{2k_B T}}$$





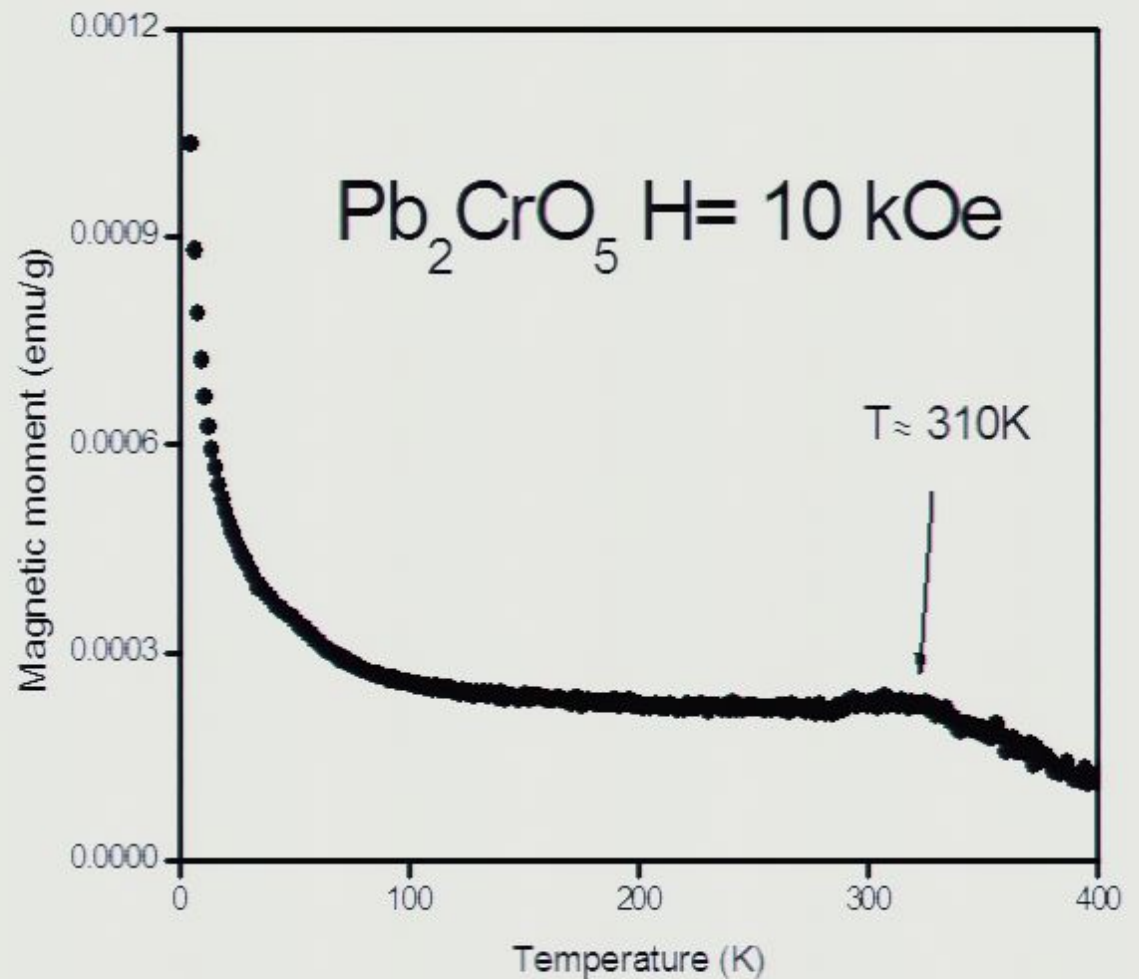
# Magnetic properties



Effective magneton numbers:

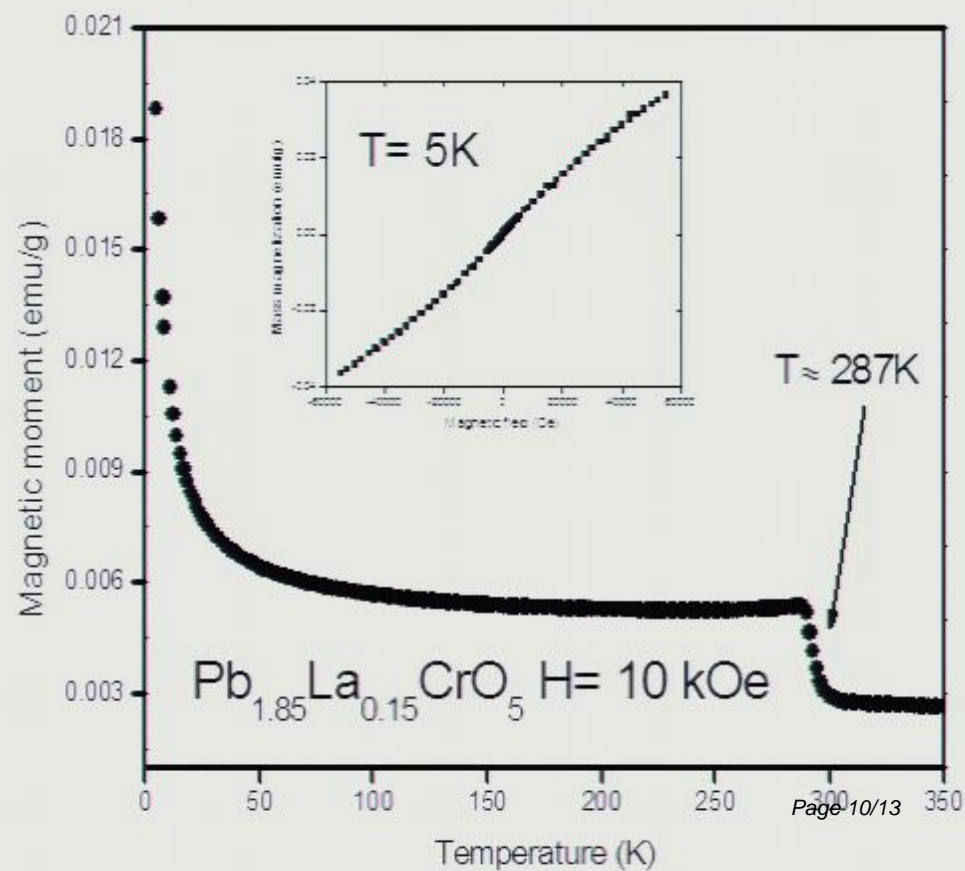
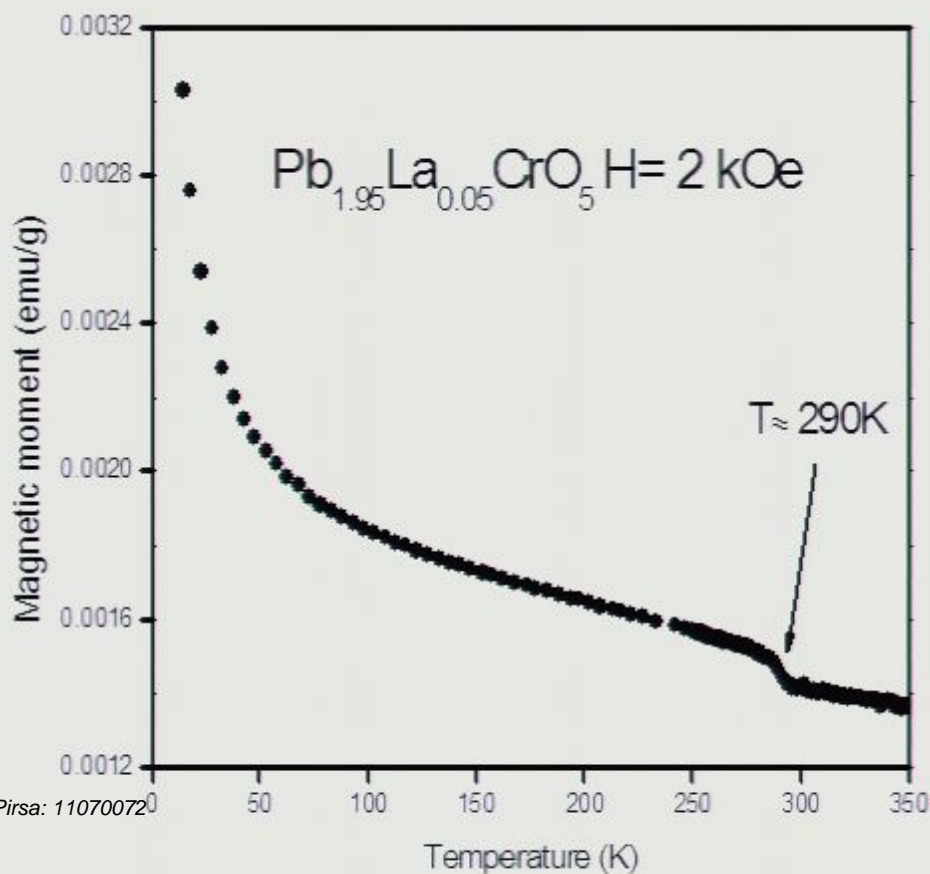
	Exp.	Calc.
$\text{Cr}^{3+} (3d^3)$	3.8	3.87

C. Kittel, *Introduction to Solid State Physics*, 8<sup>th</sup> edition, 308

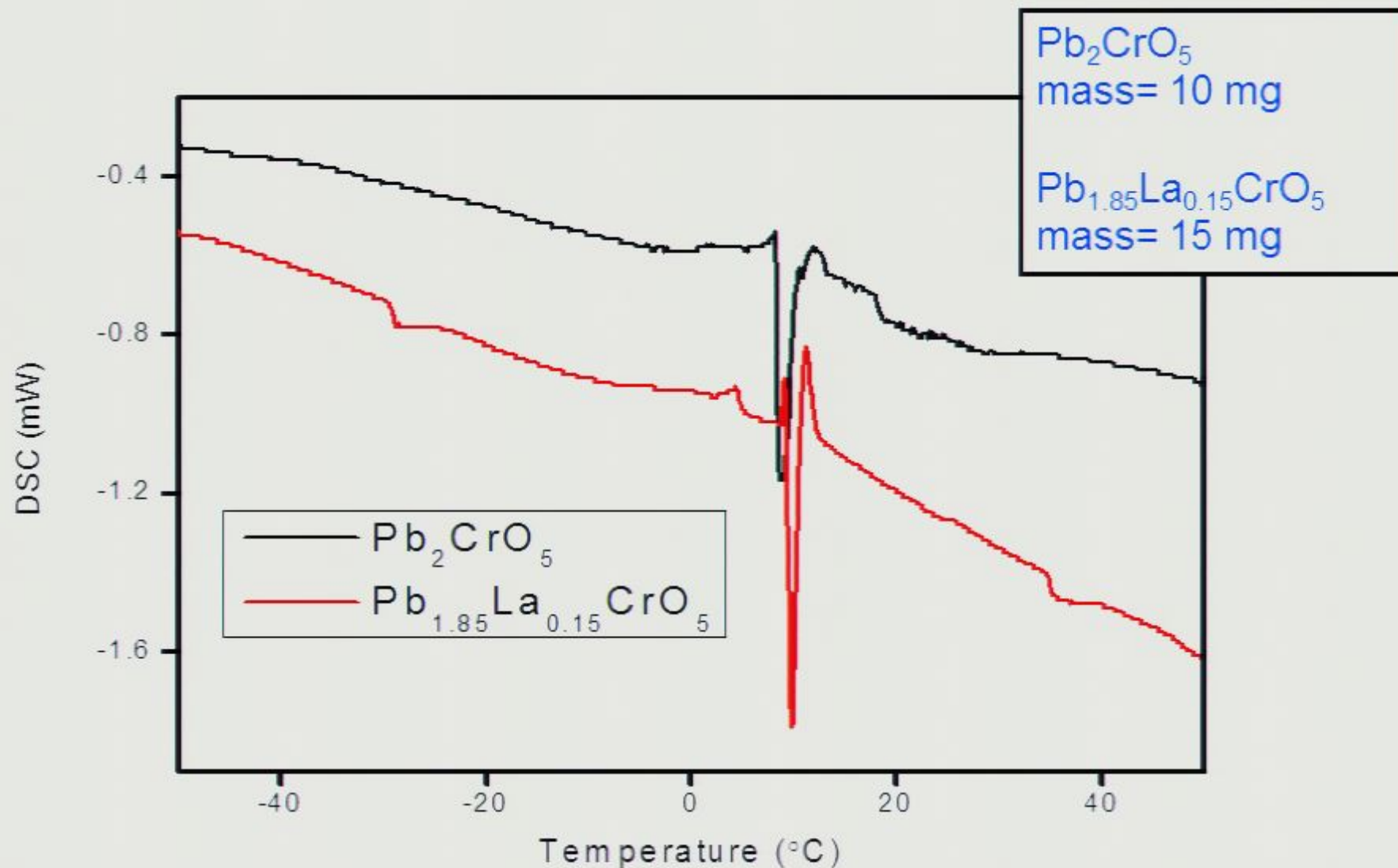


# Magnetic properties

La<sup>3+</sup> doping leads to a change in the oxidation state of



# Thermal properties



# Concluding remarks

## La doping

- ❖ Modifies the structural parameters of  $\text{Pb}_2\text{CrO}_5$
  - ❖ Causes a large reduction of the band gap
  - ❖ It induces a weak ferromagnetism
- Further work is in progress to study the chemical nature of Cr



# Thank you



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