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Structure, magnetic and dielectric characteristics of Ln_2NiMnO_6 (Ln= Nd and Sm) ceramics

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Introduction

- As a class of ferromagnetic (FM) semiconductor, La_2NiMnO_6 have gained much scientific interest, owing to their rich physics and prospects for technological applications.[1]
- the properties of the compounds with the double perovskite structure generally change noticeably with the substitution of La^{3+} by a rare-earth element with smaller ionic radius.

Methods

- Nd_2NiMnO_6 and Sm_2NiMnO_6 ceramics are prepared by solid-state sintering process, and the structure, magnetic and dielectric properties of the present ceramics have been investigated with comparison to those for La_2NiMnO_6.

Results and discussion

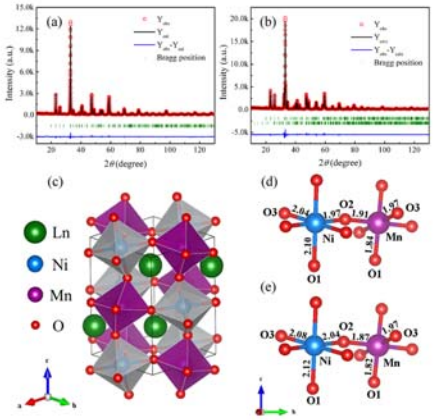

Fig.1. Rietveld analysis results of X-ray diffraction patterns for Nd_2NiMnO_6 (a) and Sm_2NiMnO_6 (b). (c) Crystal structure of Ln_2NiMnO_6 (Ln=Nd and Sm). Gray and purple octahedrons are corresponded to NiO_6 and MnO_6, respectively. (d) and (e) are local structure of NiO_6 and MnO_6 octahedrons in the Nd_2NiMnO_6 and Sm_2NiMnO_6, respectively. The bond lengths (Å) are shown in the NiO_6 and MnO_6 octahedrons.

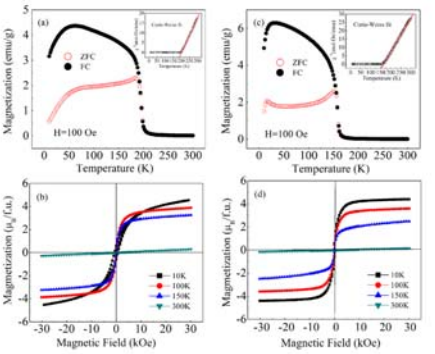

Fig.2. Temperature dependence of field cooled and zero field cooled magnetization for Nd_2NiMnO_6 (a) and Sm_2NiMnO_6 (c). The insets show inverse susceptibility and fits to the high temperature using Curie-Weiss law. Magnetic hysteresis loops of Nd_2NiMnO_6 (b) and Sm_2NiMnO_6 (d) measured at various temperatures.

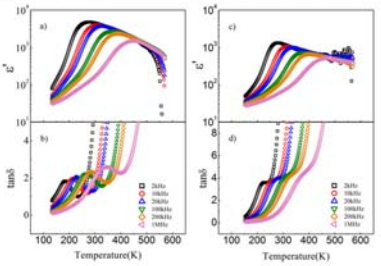

Fig.3. Temperature dependence of dielectric properties for Nd_2NiMnO_6 (a) (b) and Sm_2NiMnO_6 (c) (d).

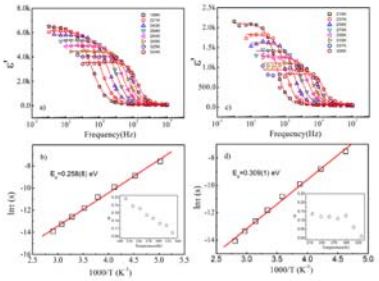

Fig.4. Frequency dependence of dielectric constant for Nd_2NiMnO_6 (a) and Sm_2NiMnO_6 (c). The solid lines are fitting results according to the modified Debye equation. The natural logarithm of the relaxation time τ vs. 1/T for Nd_2NiMnO_6 (b) and Sm_2NiMnO_6 (d). The solid lines are the Arrhenius fitting. Insets show the temperature dependence of α value.

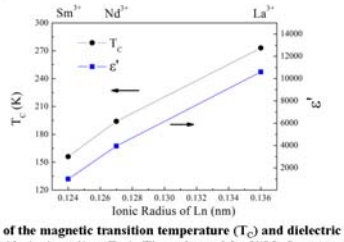

Fig.5. Evolution of the magnetic transition temperature (T_C) and dielectric constant (ε') with the lanthanide ionic radius (R_{Ln}). The values of La_2NiMnO_6 extracted from the Ref. 2.

Conclusions

- Both Nd_2NiMnO_6 and Sm_2NiMnO_6 are ferromagnetism with the monoclinic symmetry (space group $P2_1/n$). The Curie temperatures T_C of Nd_2NiMnO_6 and Sm_2NiMnO_6 is 194 K and 156 K, respectively, and it decreases with decreasing <Ni-O-Mn> bond angle which depends on R_{Ln}. Meanwhile, the dielectric constant ε' monotonically decreases with decreasing R_{Ln} in the present ceramics.
- The similar variation tendency of magnetic and dielectric properties with R_{Ln} indicates that the structural origins for the magnetic and dielectric response should be closely linked.

References

[1] N. S. Rogado, J. Li, A. W. Sleight, and M. A. Subramanian, Adv. Mater. 17, 2225 (2005)

[2] W. Z. Yang, X. Q. Liu, Y. Q. Lin and X. M. Chen, J. Appl. Phys. 111, 084106 (2012)

Acknowledgments

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