Search for ferroelectric-magnetic materials

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Alexei Belik
Quantum Materials Field / Quantum Solid State Materials Group
Alexei.Belik@nims.go.jp | http://samurai.nims.go.jp/Alexei_BELIK-e.html

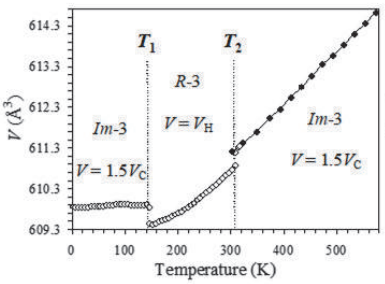
Background

- Memory density and operation speed must be improved in memory elements
- Waste heat must be reduced in a new generation of memory elements
- One possibility is to use the so-called multiferroic materials in memory elements

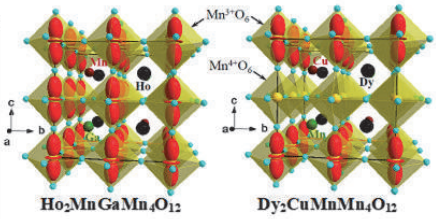
Aim

- Search for new materials with magnetic and ferroelectric transition temperatures above room temperature
- Search for materials with strong coupling between different order parameters to control magnetism by electric field and vise versa

Advanced Research Topics



Effects of the introduction of the charge degree of freedom into the B site of $BiMn_7O_{12}$ through $BiCu_xMn_{7-x}O_{12}$ solid solutions are explored. $BiCuMn_6O_{12}$ exhibits well-defined 1:3 charge order of Mn^{4+} and Mn^{3+} and orbital order of Mn^{3+} near room temperature; but both charge and orbital orders collapse below about 115 K with the reentrance of the high-temperature cubic *Im*-3 phase.



$Ho_2MnGaMn_4O_{12}$ $Dy_2CuMnMn_4O_{12}$

Chemical substitution in perovskites typically leads to a disordered arrangement of cations. The next most likely scenario is that of the so-called double (or two-cation) long-range ordering. We showed that perovskites can have an intrinsic, columnar-type triple order of cations, which presents a potentially huge subfamily of perovskite materials that have attracted remarkably little attention.

High-pressure equipment which was used for the preparation of new materials

Publications

- L. Zhang, Y. Matsushita, K. Yamaura, A. A. Belik, Inorg. Chem. 56 (2017) 5210-5218.
- A. A. Belik, Y. Matsushita, D. D. Khalyavin, Angew. Chem.: Int. Ed. 56 (2017) 10423–10427.
- A. A. Belik, Dalton Trans. 47 (2018) 3209-3217.

Summary

- Unusual structural phenomena were found in wide compositional ranges in quadruple perovskites
- A-site columnar-ordered $A_2A'A''B_4O_{12}$ quadruple perovskites were identified

Research outcome

- A potentially huge subfamily of perovskite materials was revealed
- Nearly zero-thermal expansion materials found
- New research directions were identified in quadruple perovskites