

# Development of quantum properties of solid state materials

Keywords : Spin-orbit interaction, 5d system, High-pressure synthesis

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## Background

There is a growing expectation as a new functional material for the quantum solid state materials, for which various interactions play a significant role beyond the band theory scheme. It may be possible to develop useful functionality by controlling the complex interaction in the solid, as has been suggested by many studies.

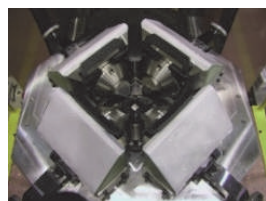
## Aim

Global issues is the achievement of operating of quantum solid state devices at room temperature. To resolve the issue, we are conducting new material study that takes advantage of NIMS and organizing the joint research projects with outside teams.

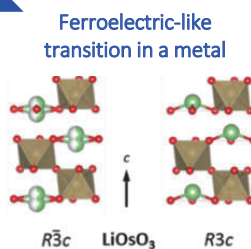
## Advanced Research Topics

- Development of transition metal oxides expected to have significant quantum properties and valuable functionality.
- Theoretical considerations and characteristics prediction by first-principles calculations.
- Development of new materials that specialize in spintronics oxide and magnetic semiconductors.

Deployment to  
the non-volatile memory function materials

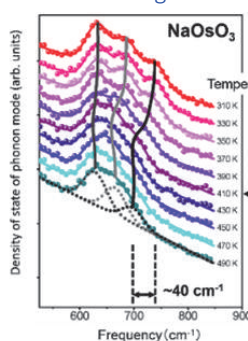


Expanding chemical compositions by such as high-pressure synthesis

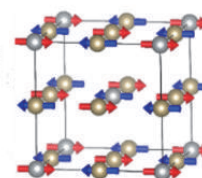


Fine structure analysis by synchrotron x-ray and neutron diffractions

Deployment to  
the magnetic sensor functional materials



Advanced characterization of quantum properties by various methods



Double perovskite oxide

Materials design and investigation by theoretical calculations

## Publications

- Vale JG, et al. (2018) Evolution of the Magnetic Excitations in NaOsO<sub>3</sub> through its Metal-Insulator Transition. Phys. Rev. Lett. 120(22):227203.
- Taylor AE, et al. (2017) Spin-Orbit Coupling Controlled  $J = 3/2$  Electronic Ground State in 5d<sub>3</sub> Oxides. Phys. Rev. Lett. 118(20):207202.

## Summary

- Function development of the noble metal oxides
- Achievement of the strongest spin-phonon coupling
- Patent Registration: 1

## Research outcome

- Magnetic sensor functional materials
- Non-volatile magnetic memory
- Magnetoresistive oxide