【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Chemistry)

Title of Project : Design of light- or electromagnetic-wave-correlating phase transition materials and research of their advanced functionalities

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Research Project Number : 15H05697 Researcher Number : 10280801
Research Area : Chemistry
Keyword : Light, Electromagnetic-wave, Phase transition, Physical chemistry

【Purpose and Background of the Research】

Phase transition materials exhibiting ferromagnetic, ferroelectric, metal-insulator phase transitions, etc., are important for electronics and recording devices supporting the basis of modern society. Light or electromagnetic (EM) waves, ranging from ultraviolet-visible light to radio waves, correlate with materials in various ways and excite different quantum states depending on the frequency. In this project, we will develop novel phase transition materials responsive to light or EM waves from the approach of basic chemistry, physical chemistry, and synthetic chemistry, and we will promote research on novel functionalities contributing to next-generation devices or energy and environmental issues. Another goal is to observe magnetic dipole excited optical effect in the millimeter wave range by the magnetic field component of the EM wave, and to construct a new field of "millimeter wave materials science".

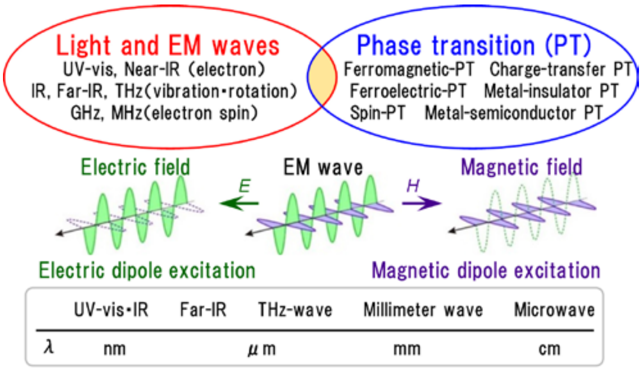
【Research Methods】

In this project, we will synthesize metal complexes and metal oxides with various optical, electrical, and magnetic functionalities and observe drastic color change and optical-switching of ionic conductivity, ferroelectricity, and ferromagnetism at room temperature triggered by light-induced phase transitions. Focusing on the wave properties of EM waves, we aim to observe instantaneous switching of nonlinear magneto-optical phenomena by external stimuli such as light, electric current, and electric field in spatially and temporally non-centrosymmetric materials such as chiral magnets or pyroelectric magnets with both electric polarization and magnetic polarization. Another goal is to discover a material group exhibiting metal-semiconductor phase transition by external stimuli.

In the millimeter wave range, the rotation angle and ellipticity of light change when the magnetic dipole is excited by the magnetic field component of the EM wave. Based on this property, we will demonstrate high performance millimeter wave Faraday effect by magnon excitation and improve the rotation and absorption efficiency. We will also investigate the coupling effect between coherent magnon and lattice vibration in metal or insulator nanomaterials.

【Expected Research Achievements and Scientific Significance】

This research project is expected to indicate new guidelines for material development from the viewpoint of correlation between light or EM waves and phase transition materials, and should provide important knowledge in the field of magnetism, photonics, etc. Construction of a new academic field "millimeter wave materials science" is also expected.



【Publications Relevant to the Project】

- "90-degree optical switching of output second-harmonic light in chiral photomagnet", S. Ohkoshi et al., **Nature Photonics**, 8, 65 (2014).
- "Hard magnetic ferrite with a gigantic coercivity and high frequency millimetre wave rotation", A. Namai et al., **Nature Communications**, 3, 1035 (2012).
- "Synthesis of a metal oxide with a room-temperature photoreversible phase transition", S. Ohkoshi et al., **Nature Chemistry**, 2, 539 (2010).

【Term of Project】 FY2015-2019

【Budget Allocation】 374,700 Thousand Yen

【Homepage Address and Other Contact Information】

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