

論文 / 著書情報
Article / Book Information

| | |
|-------------------|---|
| 題目(和文) | 非線形光学効果から見た鉄複電荷酸化物の電子強誘電性の研究 |
| Title(English) | |
| 著者(和文) | 于洪武 |
| Author(English) | Hongwu Yu |
| 出典(和文) | 学位:博士(理学), 学位授与機関:東京工業大学, 報告番号:甲第12668号, 授与年月日:2024年3月26日, 学位の種別:課程博士, 審査員:沖本 洋一,腰原 伸也,谷口 耕治,植草 秀裕,西野 智昭 |
| Citation(English) | Degree:Doctor (Science), Conferring organization: Tokyo Institute of Technology, Report number:甲第12668号, Conferred date:2024/3/26, Degree Type:Course doctor, Examiner:,,,,, |
| 学位種別(和文) | 博士論文 |
| Category(English) | Doctoral Thesis |
| 種別(和文) | 論文要旨 |
| Type(English) | Summary |

(博士課程)
Doctoral Program

論文要旨

THESIS SUMMARY

| | | | | | |
|--|-------------|----------|---|-----------------|--------|
| 系・コース： Department of, Graduate major in | 化学 エネルギー | 系 コース | 申請学位 (専攻分野)： Academic Degree Requested | 博士 Doctor of | (理学) |
| 学生氏名： Student's Name | 于 洪武 | | 審査員主査： Chief Examiner | 沖本洋一 | |

要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

This research delves into the electronic properties and potential applications of a unique class of materials known as “electronic ferroelectric” RFe_2O_4 , where R is a rare earth element or Yttrium. The object of this study is to investigate the electronic ferroelectric polarization characteristics of these materials, especially their complex interactions with light and to deepen understanding of electronic ferroelectric materials from various axes. We explored experiments on three types of electronic ferroelectric materials with different properties by changing three types of R ions: $YbFe_2O_4$, $LuFe_2O_4$, and YFe_2O_4 , and mainly used the femtosecond pulse laser.

The first major section of this research is dedicated to analyzing the properties of $YbFe_2O_4$ thin films. We focused on the ferroelectric properties of these films and clarified the possibility of using them as terahertz-generating elements using pulsed lasers. Confirmation of the ferroelectricity of these thin films is done through advanced second harmonic generation (SHG) experiments. Experimental results demonstrate that these films not only have macroscopic ferroelectricity and are efficient in generating terahertz waves, but also exhibit unique electrical properties. Such properties make $YbFe_2O_4$ thin films highly promising for the development of future light-based technological devices, which could lead to innovations in optical research and high-speed communications.

The second section of the study focuses on $LuFe_2O_4$ single crystals. In this part of the research, we investigate the optical conductivity, and SHG dependence of incident light polarization, and thoroughly investigate the ultrafast dynamics of electronic ferroelectric polarization after light irradiation. The results of these studies revealed the anisotropic behavior of $LuFe_2O_4$ crystals. Unlike conventional ferroelectric materials, it was observed that electronic ferroelectric polarization in this system increases after photoexcitation. This suggests the potential application of this crystal as an ultrafast optical devices. It has also led to the elucidation of the special characteristics of electronic ferroelectric polarization in terms of physics study.

The final part of this study focuses on the synthesis and examination of YFe_2O_4 crystals. Previous research indicated that the charge order of this crystal undergoes phase transitions as the temperature changes. We first succeeded in synthesizing a single crystal of this system and elucidated the complex charge-ordered phase of this system from three perspectives: SHG, X-rays, and magnetic susceptibility. Additionally, experiments involving the application of a magnetic field at room temperature revealed that YFe_2O_4 is a new category of multiferroic materials. This discovery is groundbreaking and will greatly contribute to the understanding of electronically fluctuating materials. It may also lead to the addition of innovative chapters to the classification and understanding of materials in this field.

In conclusion, this research examines the RFe_2O_4 system by investigate their interactions with light and reveal their distinctive electrical and magnetic features through a variety of experimental approaches. The insights gained are invaluable for the development of novel optical devices and technologies, also indicate that electronic ferroelectric materials have great potential for future applications and physical research.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note：Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

注意：論文要旨は、東工大リサーチリポジトリ(T2R2)にてインターネット公表されますので、公表可能な範囲の内容で作成してください。

Attention: Thesis Summary will be published on Tokyo Tech Research Repository Website (T2R2).