

論文 / 著書情報  
Article / Book Information

題目(和文)	
Title(English)	A study on lateral-type spin-photodiodes based on metal-insulator-semiconductor junctions
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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

専攻： 物理電子システム創造 専攻  
Department of  
学生氏名： Roca Ronel Christian Intal  
Student's Name

申請学位 (専攻分野)： 博士 (Engineering)  
Academic Degree Requested Doctor of  
指導教員 (主)： 宗片 比呂夫  
Academic Supervisor(main)  
指導教員 (副)：  
Academic Supervisor(sub)

要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words )

This is a brief summary of the thesis entitled "A study on lateral-type spin-photodiodes based on metal-insulator-semiconductor junctions". The purpose of the study is to analyze and improve the performance of lateral spin-PDs. In particular, the goals of the study are as follows: first, to experimentally investigate the origin of the low  $F$  in lateral spin-PDs; second, to develop a simulation model for lateral spin-PDs; and third, to improve the design of lateral spin-PDs with the following in mind: room temperature operation, no external magnetic field operation, improved quantum efficiency, and improved  $F$ . The thesis has seven chapters and are outlined as follows:

Chapter 1 - Introduction. In this chapter, a background of the field of semiconductor spintronics and spin-optoelectronics are discussed. A literature survey of previous studies on spin-photodiodes is presented. Furthermore, other competing technologies are also mentioned.

Chapter 2 - Physics of spin-photodiodes. In this chapter, the theory and framework of the working principle of spin-photodiodes are discussed. The optical selection rules in zinc-blende semiconductors, spin relaxation mechanisms in semiconductors, and a spin-dependent tunneling model are presented.

Chapter 3 - Experimental techniques. In this chapter, the experimental methods, as well as the working principle of experimental machines and setups, are introduced. The basics of III-V semiconductor wafer growth and device fabrication is discussed. These include molecular beam epitaxy, photolithography, and vacuum deposition techniques. Additionally, electrical, optical, and structural characterization techniques of spin-photodiodes are also tackled. These include electrical characterization, photocurrent measurement, and SQUID measurement.

Chapter 4 - Simulation of spin-photodiodes. In this chapter, the development of the simulation models for spin photodiodes is discussed. Standard numerical techniques and semiconductor computational models are introduced. In particular, the incorporation of spin-dependent physics to the models are presented.

Chapter 5 - Cleaved spin-photodiode. In this chapter, the investigation of a cleaved spin-photodiode is presented. The experiment and results of side and oblique angle illumination are discussed. The analysis and recommendation are also mentioned. In particular, results show a spin detection efficiency  $F \sim 0.14\%$  and  $1.3\%$  for lateral and oblique angle illumination respectively. Furthermore, a comparison of the experimental results with the simulation suggests that the low  $F$  for the lateral illumination case is due to the damage of the spin tunnel barrier at the cleaved edge of the device.

Chapter 6 - Refracting-facet spin-photodiode. In this chapter, the development of a novel spin-photodiode structure is presented. Experiment as well as simulation results are discussed. An experimentally measured  $F \sim 0.4\%$  was achieved for the fabricated refracting-facet spin-photodiode. Simulation results suggest that the low  $F$  is due to the poor quality of the Fe contact, with an effective spin polarization  $P_{Fe} \sim 1\%$ , much lower than the literature value of  $42\%$ . A potential  $F$  up to  $19\%$  can be achieved if the Fe contact quality can be improved.

Chapter 7 - Conclusions and future prospects. In this chapter, conclusions drawn from the analysis of the results are presented. Possible improvements and potential performance limits are also discussed. Furthermore, the implications and possible applications of the results are also mentioned.

This thesis is submitted as a partial requirement for the degree of Doctor of Engineering from the Department of Electronics and Applied Physics of Tokyo Institute of Technology.

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).

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