RGC Ref.: M-HKUST605/13
(please insert ref. above)

The Research Grants Council of Hong Kong
SRFDP & RGC ERG Joint Research Scheme
Completion Report

(Please attach a copy of the completion report submitted to the Ministry of Education by the Mainland researcher)

Part A: The Project and Investigator(s)

1. Project Title

Control of the fabrication process and properties of multifunctional magnetoelectric oxide films

2. Investigator(s) and Academic Department/Units Involved

	Hong Kong Team	Mainland Team
Name of Principal Investigator *(with title)*	Prof. Jiannong Wang	Prof. Hong Wang
Post	Professor	Professor
Unit / Department / Institution	Physics/HKUST	Electronics/Xi'an Jiaotong University
Contact Information	Email: phjwang@ust.hk	Email: hwang@xjtu.edu.cn
Co-investigator(s) *(with title and Institution)*		Associate Prof. Ming Liu / Xi'an Jiaotong University
PhD student(s) (with period of involvement)	Name: Miss Rong Ma Institution: HKUST Period from January 2014 to December 2016 Name: Mr. Changming Wu Institution: HKUST Period from September 2014 to December 2016	Name: Miss Rong Ma Institution: XJTU Period from January 2014 to December 2016

Note: The Hong Kong project team must involve at least one research postgraduate student pursuing a Doctor of Philosophy degree at the UGC-funded university (PhD student) at any time throughout the project period.

3. Project Duration

	Original	Revised	Date of RGC/ Institution Approval *(must be quoted*)
Project Start date	01 Jan 2014		
Project Completion date	31 Dec 2016		
Duration *(in month)*	36		
Deadline for Submission of Completion Report	31 Dec. 2017		

Part B: The Completion Report

5. Project Objectives

5.1 Objectives as per original application

1. Develop a controlled process for producing multifunctional oxides in the form of textured films and multilayer films.
2. Characterize the interface structure, the electrical and magnetic properties of the obtained multifunctional oxide films.
3. Elucidate the influence of ion substitution, defect, size, strain, and interfacial mapping on the electrical and magnetic properties of the obtained multifunctional oxide films in order to enhance their magnetoelectric properties.

5.2 Revised Objectives

Date of approval from the RGC: _____

Reasons for the change: _____

_____

1.
2.
3. ....

6. Research Outcome

Major findings and research outcome
(maximum 1 page; please make reference to Part C where necessary)

We have successfully grown epitaxial single crystalline YIG thin films on (111)-oriented GGG at room temperature via RF sputtering followed by a short-time post-annealing treatment. Their structural and physical properties have been carefully studied and compared with that of YIG/GGG(111) thin films deposited at high temperatures. The relatively large saturated magnetization (~120 emu/cc) and a comparable linewidth (~55 Oe) of those room-temperature-deposited YIG thin films are achieved. This provides a viable alternative for growing YIG thin films on GGG or other garnet substrates. The results are published in the Journal of Alloys and Compounds.

We have tried to fabricate s layer-by-layer magneto-dielectric composite consisting of CFO and BTO by certain casting method followed by conditional sintering technique. The structure is expected to possess large magneto-dielectric (MDE) coupling. The MDE coupling of those samples are under investigations.

We have studied the relationship between magneto-dielectric properties and ions occupation of (1-y) $(Mg_{0.95}Zn_{0.05})_2TiO_4$ - y $Mg_{0.95}Zn_{0.05}Fe_2O_4$ solid-solution series, where y was chosen as 0, 0.1, 0.3, 0.7, 0.9 and 1. This solid-solution was expected to possess better dielectric and magnetic properties with the increase of $Mg_{0.95}Zn_{0.05}Fe_2O_4$ powder composition. The doping of Zn element could greatly lower the sinter temperature by several hundred degrees for the binary titanate ceramics. The XRD, SEM, dielectric measurement and I-V test for these samples have been carried out. These samples gradually display colossal dielectric properties at low frequency with the increase of $Mg_{0.95}Zn_{0.05}Fe_2O_4$. The magnetic property measurements are in the progress. A manuscript is under preparation.

Potential for further development of the research and the proposed course of action
(maximum half a page)

This project has led to further collaborations of the two groups. We will continue our collaborative research in investigating the hybrid structures of low-dimensional functional oxide thin films and 2D semiconductors.

7. The Layman's Summary

(describe <u>in layman's language</u> the nature, significance and value of the research project, in no more than 200 words)

With the rapid advances in information and wireless technologies, materials for fabricating electronic components with shrinking dimensions and high levels of passive integration are attracting increasing attention. Natural magnetoelectric single-phase compounds are rare, so most of the research is focused on magnetoelectric composites, which incorporate ferroelectric and ferri-/ferromagnetic phases artificially. In this project, we have studied ferromagnetic and multifunctional composite oxides. We develop a viable alternative for growing ferromagnetic YIG thin films on various substrates and we investigate the influence of ion substitution in a multifunctional composite oxide.

Part C: Research Output

8. Peer-reviewed journal publication(s) arising directly from this research project

(Please attach a copy of each publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.))

The Latest Status of Publications				Author(s) ***(bold** the authors belonging to the project teams and denote the corresponding author with an asterisk*)*	Title and Journal/ Book *(with the volume, pages and other necessary publishing details specified)*	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of this Joint Research Scheme *(Yes or No)*	Accessible from the institutional repository *(Yes or No)*
Year of publication	Year of Acceptance *(For paper accepted but not yet published)*	Under Review	Under Preparation *(optional)*						
2017				**Rong Ma, Ming Liu, Jiannong Wang*, and Hong Wang***	The room temperature deposition of high-quality epitaxial yttrium iron garnet thin film via RF sputtering, *Journal of Alloys and Compounds*, **708**, pp213-219	2017	yes	yes	yes

9. Recognized international conference(s) in which paper(s) related to this research project was/were delivered

(Please attach a copy of each delivered paper. All listed papers must acknowledge RGC's funding support by quoting the specific grant reference.)

Month/Year/ Place	Title	Conference Name	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of this Joint Research Scheme *(Yes or No)*	Accessible from the institutional repository *(Yes or No)*

10. Student(s) trained *(Please attach a copy of the title page of the thesis.)*

Name	Degree registered for	Date of registration	Date of thesis submission/ graduation
Rong Ma	PhD	Sept. 2013	expected Aug 2018

11. Other impact *(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, etc.)*

N/A