سامية محمد مصطفى



شبكة المعلومات الحامعية

بسم الله الرحمن الرحيم



-Caro-

سامية محمد مصطفي



شبكة العلومات الحامعية



شبكة المعلومات الجامعية التوثيق الالكتروني والميكروفيلم





سامية محمد مصطفى

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسو

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأقراص المدمجة يعيدا عن الغيار



سامية محمد مصطفي



شبكة المعلومات الجامعية



المسلمة عين شعور المسلمة عين شعور المسلمة عين شعور المسلمة عين شعور المسلمة ا

سامية محمد مصطفى

شبكة المعلومات الحامعية



بالرسالة صفحات لم ترد بالأصل





Mössbauer and Magnetic Studies of Manganese Ferrite; Fine Particles and Thin Films

A Thesis

Submitted to the faculty of Science
Assiut university

For

Ph.D. degree in physics

By 🝇

Mohamed Housam Mahmoud

M.Sc. (Physics)
Faculty of science, Assiut university

Under the supervision of

Professor

Professor

Abdalla Ibrahim Abdel-Mageed

Mohamed Khorshid Fayek

Professor

Dr.

Ahamed Shawky Elgammal

Atef Mohamed Abdallah

B 10717 Physics Department Assiut university 1999

بَالِنَهُ الْخُالِحُ لِلْخُالِثُهُ الْخُالِحُ لِنَكُمُ الْمُعَالِمُ الْمُعِلَّمُ الْمُعَالِمُ الْمُعَالِمُ الْمُعَالِمُ الْمُعَالِمُ الْمُعِلَّمُ الْمُعَالِمُ الْمُعَالِمُ الْمُعَالِمُ الْمُعَالِمُ الْمُعِلِمُ الْمُعَلِمُ الْمُعِلِمُ الْمِعِلِمُ الْمُعِلِمُ الْمُعِلَمُ الْمُعِلِمُ الْمُعِلِمُ الْمُعِلِمُ الْمُعِلِمُ لِمِعِلَمِ الْمُعِلَمِ الْمُعِلِمُ الْمُعِلِمُ الْمُعِلِمُ الْمُعِلِمُ لِمِعِلَمِ الْمُعِلَمُ الْمُعِلَمُ الْمُعِلَمُ الْمُعِلِمُ الْمُعِلِمُ الْمُعِلَمُ الْمُعِلِمُ الْمُعِلِمِ الْمُعِلِمُ الْمُعِلِمِ الْمُعِلِمُ الْمُعِلِمُ الْمُعِلِمِ الْمُعِلِمِي الْمُعِلِمُ لِمِعِلَمِ الْمُعِلِمُ الْمُعِلِمُ الْمُعِلِمُ الْمُعِلِمِ لِلْمِ

الحديد فيه بأس شديد ومنافع للناس المحديد فيه بأس شديد ومنافع للناس المحديد أية ٢٥)

In the name of God

We sent our messengers supported by clear proofs, and we sent down to them the scripture law, that the people may uphold justice.

And we sent down the iron, wherein there is strength, and many benefits for the people

All this in order for GOD to distinguish those who would support Him and His messengers, on faith. GOD is Powerful, Almighty.

(Verse 25 **Iron** chapter)

Acknowledgement

Acknowledgement

I would like to express my deep gratitude to Prof. A. I. Abdel-Mageed, Prof. A. S. Elgammal and Dr. A. M. Abdallah, Physics dept. Assiut University, Egypt, for encouragement and supervision of this work.

I would like also to express my thanks to Prof. M. K. Fayek, chairman of atomic reactor division (atomic energy authority) Egypt, for useful guidance, encouragement and supervision.

I am grateful to Prof. J. C. Walker, Physics dept., Johns Hopkins university, Maryland USA and his Co-workers for the continuos help during the period of my stay (2 years) at Johns Hopkins university. Many thanks also to Miss Batty Carroll (secretary of Physics dept. at Johns Hopkins Univ.) for her help.

I am indebted to Prof. C. M. Williams, Physics dept. Morgan state university, Maryland USA and his coworkers for the continuos help during the experimental work, providing the facilities for preparing the films and valuable discussion through this work.

I am indebted also to Dr. H. H. Hamdeh, Physics dept. Wichita state university, for offering many experimental facilities, providing the high field Mössbauer measurements and valuable discussion through this work.

I am grateful also to Prof. M. S. Abdelazeem, Physics dept., Assiut University Egypt, for the continuos help during writing of this manuscript.

Special thanks go to my wife for the abnormal life style during the preparation of this work.

Contents

Contents

		Page
Abstract		1
Chapter one	Introduction	
1.1	Historical review	3
1.2	Industrial applications of ferrites	4
1.3	Nature of ferrites	6
1.3.1	Chemistry	6
1.3.2	Structure	6
1.3.3	Cation distribution in spinel ferrites	11
1.4	Origin of magnetism in ferrites	13
1.4.1	Direct exchange interaction	13
1.4.2	Indirect exchange interaction (superexchange)	16
1.5	Magnetic anisotropy in small particles	19
1.6	Coercivity of small particles	20
1.7	Mössbauer effect studies	22
1.7.1	Introduction	22
1.7.2	Isomer shift	24

			* .
			Page
	1.7.3	Quadrupole hyperfine interaction	26
	1.7.4	Magnetic hyperfine interaction	28
	1.7.5	Time-dependent effects (relaxation in Mössbauer spectra)	32
	1.7.6	Mössbauer spectra in the presence of fluctuation of the magnetization	35
	1.8	Aim of the present work	40
	СНАРТЕ	R 2 Experimental Methods	
	2.1	Preparation techniques	43
	2.1.1	Processing of the Polycrystalline sample by usual ceramic technique	43
	2.1.2	Processing of fine particle samples by High energy ball milling (HEBM)	45
	2.1.3	Processing of thin film samples by pulsed laser deposition (PLD)	48
•	2.2	Experimental devices	58
	2.2.1	X-ray diffraction technique	58
	2.2.2	Scanning electron microscope (SEM)	58
	2.2.3	Transmission electron microscopy (TEM)	59
	2.2.4	Energy dispersive x-ray spectroscopy (EDS)	59
	2.2.5	SQUID magnetometer	. 59
	2.2.6	Mössbauer spectrometer	61

CHAPTER 3	Size Dependent Magnetic Properties Of Manganese Ferrite Fine Particles	
3.1	Introduction	62
3.2	Sample preparation & characterization	64
3.2.1	X-ray diffraction investigation	64
3.2.2	TEM investigation	67
3.3	Results & discussion	72
3.3.1	Magnetic results	72
3.3.1.1	Hysteresis loops and coercivity	72
3.3.1.2	Low field FC-ZFC measurements	74
3.3.1.3	Saturation magnetization measurements	76
3.3.2	Mössbauer investigations	77
3.3.2.1	Room temperature Mössbauer investigation	77
3.3.2.2	High magnetic field Mössbauer investigation	83
3.3.3	Origin of spin canting	88
3.3.4	Decrease of the magnetization with particle size reduction	91
CHAPTER 4	Studying of Manganese Ferrite Films Processed By Pulsed Laser Deposition (PLD))
4.1	Introduction	94
4.2	Overview	96

			Dage
			Page
	4.2.1	Electronic processes in laser ablation of semiconductors and insulators	96
	4.2.2	Theoretical approach	98
	4.3	Experimental procedure	103
	4.4	Results & discussion	104
	4.4.1	Growth and structural characterization	104
	4.4.1.1	XRD investigation	104
	4.4.1.2	Scanning electron microscope investigation	110
	4.4.2	Mössbauer investigations	112
	4.4.2.1	Mössbauer investigations at low temperature	112
	4.4.2.2	Mössbauer investigations at high temperature	118
	4.4.3	Magnetization investigations	121
	4.4.3.1	Hysteresis loops & coercivity	121
	4.4.3.2	Saturation magnetization measurements	124
·	Summary & Conclusions References		127
			131
:	Appendix	A List of symbols	137
		•	

Abstract