

## CONTENTS

	<b>Page</b>
<b>ACKNOWLEDGEMENTS</b>	<b>iii</b>
<b>ABSTRACT (ENGLISH)</b>	<b>iv</b>
<b>ABSTRACT (THAI)</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>x</b>
<b>LIST OF FIGURES</b>	<b>xi</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xv</b>
<b>THE RELEVANCY OF THE RESEARCH WORK TO THAILAND</b>	<b>xviii</b>
<b>CHAPTER I INTRODUCTION</b>	<b>1</b>
1.1 Elemental distribution in human hair	1
1.2 Applicability of LA-ICP-MS for human hair analysis	3
<b>CHAPTER II OBJECTIVES</b>	<b>4</b>
<b>CHAPTER III LITERATURE REVIEWS</b>	<b>5</b>
3.1 Lead	5
3.1.1 Lead exposure	6
3.1.1.1 Environmental exposure	6
3.1.1.2 Occupational exposure	6
3.1.2 Lead metabolism	7
3.1.3 Lead intoxication	8
3.1.4 Lead analysis	9
3.1.4.1 Direct biological markers	9
3.1.4.2 Indirect biological markers	10
3.2 Human hair analysis	12
3.3 Quantitation strategies for LA-ICP-MS	14
3.3.1 Calibration using matrix-matched solid standard	14

## CONTENTS (cont.)

	<b>Page</b>
3.3.2 Solution-based calibration	15
3.3.2.1 Dual gas flow system	15
3.3.2.2 Single gas flow system	16
3.3.3 Direct liquid ablation	17
<b>CHAPTER IV MATERIALS AND METHODS</b>	<b>18</b>
4.1 Instrument and apparatus	18
4.1.1 Inductively coupled plasma mass spectrometer (ICP-MS)	18
4.1.2 Laser ablation unit	19
4.1.3 Water bath incubation shaker	20
4.1.4 Vacuum oven	20
4.1.5 Centrifuge	20
4.1.6 Analytical balance	20
4.1.7 pH meter	21
4.2 Setup of laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS)	21
4.3 Chemical reagents and materials	22
4.4 Preparation of solutions	23
4.4.1 Lead standard solutions	23
4.4.2 Tris(hydroxymethyl) aminomethane-hydrochloric (Tris-HCl) pH 8.5 solution	24
4.4.3 Hair protein extractant (Shindai solution)	24
4.4.4 Denaturant solutions	24
4.5 Preparation of human hair samples	24
4.5.1 Hair sampling	24
4.5.2 Hair cleaning	25

## CONTENTS (cont.)

		<b>Page</b>
4.6	Preparation of matrix-matched hair standards	25
4.6.1	Lead-enriched hair strand standard	25
4.6.2	Lead-enriched hair film standard	26
	4.6.2.1 Extraction of hair proteins	26
	4.6.2.2 Preparation of hair film	26
4.7	Determination of the elemental content in matrix-matched hair standard and hair samples by dissolution methods	27
4.8	LA-ICP-MS data processing	27
4.9	Calculation of elemental concentrations and detection limits using LA-ICP-MS	28
<b>CHAPTER V</b>	<b>RESULTS AND DISCUSSION</b>	<b>30</b>
5.1	Human hair analysis	30
5.1.1	Optimization of LA-ICP-MS parameters	30
	5.1.1.1 Spot size	30
	5.1.1.2 Laser energy	31
	5.1.1.3 Repetition rate	32
	5.1.1.4 Scan rate	33
5.1.2	Effect of hair sampling	35
5.1.3	Effect of hair cleaning	37
	5.1.3.1 IAEA method	37
	5.1.3.2 Cleaning with diluted acid	39
5.1.4	Distribution measurement of lead along human hair strands by LA-ICP-MS	39
5.2	Matrix-matched hair standards	41
5.2.1	Lead-enriched hair strand standard	41
	5.2.1.1 Feasibility study	41

**CONTENTS (cont.)**

	<b>Page</b>
5.2.1.2 Homogeneity study	43
5.2.1.3 Calibration study	44
5.2.2 Lead-enriched hair film standard	45
5.2.2.1 Feasibility study	45
5.2.2.2 Homogeneity study	47
5.2.2.3 Calibration study	49
5.3 Application of matrix-matched hair standards	50
5.3.1 Quantification of Pb in hair strands with known concentration	50
5.3.2 Quantification of Pb in worker's hair samples	52
<b>CHAPTER VI CONCLUSION</b>	<b>58</b>
<b>REFERENCES</b>	<b>59</b>
<b>APPENDICES</b>	<b>66</b>
<b>BIOGRAPHY</b>	<b>69</b>