

CONTENTS

ACKNOWLEDGEMENTS.....	vii
PREFACE.....	ix
LIST OF PUBLICATIONS.....	xiii

CHAPTER 1

Introduction

1.1. Laser plasma interactions.....	1
1.2. Plasma hydrodynamics and numerical modelling.....	2
1.3. Outcomes of numerical modelling.....	6
1.4. Plasma emissions induced by nanosecond and femtosecond laser pulses.....	7
1.5. Ablation mechanisms.....	8
1.6. Features of femtosecond laser-matter interaction.....	10
1.7. References.....	11

CHAPTER 2

Laser induced plasma emissions from some planar solid targets

2.1. Introduction.....	15
2.2. Experimental setup.....	15
2.3. Titanium dioxide and Titanium	
2.3.1. Plasma emissions and emission profiles.....	17
2.3.2. Time and space evolution of electron density.....	23
2.3.3. Time and space evolution of plasma temperature: Boltzmann plot method.....	29
2.4. Aluminium oxide and Aluminium	
2.4.1. Time of flight for plasma species.....	34
2.4.2. Development of electron density in space and time.....	37
2.4.3. Evaluation of plasma temperature from line intensities of subsequent ionization stages: space and time evolution.....	42
2.5. Tin oxide and Tin	
2.5.1. Emission profiles with pure and oxide targets.....	49
2.5.2. Electron density evolution in space and time scales.....	51

2.5.3	Calculation of plasma temperature along resolved space and time.....	54
2.6.	Summary.....	57
2.7.	References.....	57

CHAPTER 3

Plasma diagnostics using probe signals derived from plasma source target

3.1.	Introduction.....	59
3.2.	Initial stages of plasma formation from solid targets in vacuum	
3.2.1.	Light absorption and surface heating.....	60
3.2.2.	Effects of melting and vapourization.....	60
3.2.3.	Thermal ionization.....	61
3.2.4.	Ionization through multi-photon processes.....	62
3.3.	Scope of the work.....	62
3.4.	Expansion dynamics of laser induced plasma (LIP) in field free space	
3.4.1.	Experimental works in detail.....	63
3.4.2.	Discussion of results.....	64
3.4.3.	Summary.....	70
3.5.	Effect of external magnetic field on the probe signals	
3.5.1.	Introduction.....	70
3.5.2.	Experiment and results.....	71
3.5.3.	Summary.....	73
3.6.	References.....	74

CHAPTER 4

Optical emissions from laser induced breakdown in external magnetic field

4.1.	Introduction.....	75
4.2.	Effect of magnetic field on laser induced plasma.....	76
4.3.	Dynamics of LIP in magnetic field.....	76
4.4.	Experimental set-up.....	78
4.4.1.	Helmholtz coil.....	79
4.4.2.	Rectifier circuit.....	80
4.4.3.	Capacitor bank.....	80
4.4.4.	Ignitron.....	83

4.4.5.	Level converter circuit.....	83
4.4.6.	Micro-controller.....	83
4.4.7.	Optocoupler.....	84
4.4.8.	Working.....	84
4.4.9.	Laser synchronization.....	84
4.5.	Discussion of results	
4.5.1.	Effect of magnetic field on intensity and time delay of plasma emissions in vacuum.....	86
4.5.2.	Effect of magnetic field on LIP in argon ambient.....	88
4.5.3.	Splitting of neutral line profiles.....	90
4.6.	Summary.....	91
4.7.	References.....	92

CHAPTER 5

Tomographic reconstructions of optical emissions from laser induced plasma

5.1.	Introduction.....	95
5.2.	Tomography of laser induced plasma.....	95
5.3.	Plasma bremsstrahlung and line radiation.....	96
5.4.	Plasma density from chord - integrated emissivity.....	98
5.5.	Pixel method for tomographic reconstruction.....	98
5.6.	Linear regularization	
5.6.1.	First order linear regularization.....	102
5.6.2.	Second order linear regularization.....	103
5.7.	Irradiance dependence of LIP emissivity by pixel method.....	103
5.8.	Reconstruction of time evolution of LIP emissions by pixel method.....	106
5.9.	Summary.....	108
5.10.	References.....	108

CHAPTER 6

Study of plasma dynamics using reconstruction of digital interferograms

6.1.	Introduction.....	111
6.2.	Basic theory of the technique	
6.2.1.	Introduction.....	112

6.2.2.	Hologram recording and reconstruction.....	113
6.2.3.	Holographic interferometry (HI).....	114
6.2.4.	Digital holography.....	115
6.2.5.	Digital holographic interferometry (DHI).....	115
6.3.	Relation between interference phase and free electron density.....	116
6.4.	Scalar diffraction theory using angular spectrum propagation.....	116
6.5.	Numerical reconstruction by angular spectrum approach.....	119
6.6.	Details of the experiment.....	122
6.7.	Retrieval of plasma phase maps from digital interferograms.....	123
6.8.	Determination of chord-integrated electron density.....	125
6.9.	Inversion method for determining radial electron density profile	
6.9.1.	Abel inversion.....	128
6.9.2.	Discrete Abel transform.....	129
6.9.3.	Discrete Abel inversion method.....	130
6.10.	Reconstruction of radial density profiles from plasma phase maps.....	131
6.11.	Summary.....	135
6.12.	References.....	135

CHAPTER 7

Concluding remarks and some outlooks

7.1.	Conclusions.....	139
7.2.	Future prospects.....	140