

MASTER'S THESIS

Pulsed laser ablation of liquids for spectrochemical analysis: effects of laser wavelength

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Pulsed Laser Ablation of Liquids for
Spectrochemical Analysis:
Effects of Laser Wavelength

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A thesis submitted in partial fulfillment of
the requirements for the degree of
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ABSTRACT

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The plasma emissions produced by pulsed (~ 10 ns) laser ablation of liquid jets were monitored for spectrochemical analysis. A Nd:YAG laser at 532 nm and an excimer (ArF) laser at 193 nm, both with energy fluence of $3\text{J}/\text{cm}^2$, were used to ablate aqueous solution containing sodium, lithium, rubidium and calcium as analytes. By spectroscopically measuring the temperature and electron density of the plasma produced, two different models were gotten for the two laser wavelengths. A typical laser induced breakdown plasma was generated by the 532-nm laser. The 'hot' plasma was up to a few eV in temperature and the electron density was in the 10^{18} cm^{-3} range. The analyte line emission signals during the initial hundred ns were strongly interfered by the plasma continuum emissions. The desired signals would emerge above the background only when the plasma temperature dropped beneath 1 eV. Since the ionization was thermally induced, the initial intense plasma emission could not be prevented. The signal-to-background ratio could not be significantly improved by either spatial or temporal window techniques because of the inherent instability of jet ablation. In sharp contrast, a 'cool' plasma with much lower temperature was produced by the 193-nm laser. The temperature was on the order of fractions of eV. The electron density, however, was comparable to the 532 nm case. The non-thermal ionization process led to relatively dim plasma emissions while the analyte line emission signals were a thousand times stronger. As a result, the 193-nm laser is an ideal ablation source for sampling biologically important elements with emissions in the visible, such as sodium and potassium.

CONTENTS

Abstract	ii
Acknowledgments	iii
List of Tables	vi
List of Figures	vii
Chapter I Introduction.....	1
1.1. Background	1
1.2. Motivation	2
1.3. Laser-based Spectroscopic Technique.....	3
1.3.1 LIFS	3
1.3.2 LIBS.....	4
1.4. Aim of Study.....	6
Chapter II. Theory	8
2.1. Plasma	8
2.1.1 Definition of Plasma.....	8
2.1.2 Evolution of Laser-induced Plasma.....	8
2.2. Thermal Equilibrium	13
2.2.1 Complete Thermodynamic Equilibrium.....	13
2.2.2 Local Thermal Equilibrium	17
2.2.3 Criterion for LTE.....	19
2.3. Atomic Processes in Plasma	20
2.3.1 Excitation.....	20
2.3.2 Radiative Emission	25
2.3.3 Line Broadening Mechanism.....	28
2.4. Plasma Diagnostics.....	31
2.4.1 Electron Temperature	32
2.4.2 Electron Density	36
Chapter III Experiments	39
3.1. Solution Preparation	39
3.1.1 Absorbant Solution	39
3.1.2 Analyte Solution	40
3.2. Apparatus and Setup.....	42
3.2.1 Flow Cell Assembly	42
3.2.2 Laser Ablation Setup	43
3.3. Procedures, Conditions and Parameters	48
3.4. Optical System Calibration.....	52
3.4.1 Laser Fluence Calibration.....	52
3.4.2 ICCD Calibration.....	52

Chapter IV	Results and Discussions.....	54
4.1	PMT Detection.....	54
4.1.1	532-nm Laser Ablation Results.....	54
4.1.2	193-nm Laser Ablation Results.....	60
4.2	ICCD Detection.....	65
4.2.1	Stray Light Masking.....	65
4.2.2	Standard Lamp Spectra.....	72
4.2.3	532-nm Laser-induced Plasma Spectra.....	76
4.2.4	193-nm Laser-induced Plasma Spectra.....	89
4.2.5	248-nm Laser-induced Plasma Spectra.....	104
4.3	Plume Sizes.....	108
4.4	Discussions.....	110
4.4.1	Excitation Mechanism.....	110
4.4.2	Thermal Bath Model.....	113
4.4.3	Validating LTE.....	118
4.4.4	Laser Heating.....	121
4.4.5	Laser Supported Detonation Wave.....	121
4.4.6	Electron Lifetime.....	122
4.4.7	Summary.....	125
Chapter V	Conclusion.....	127
5.1	Conclusion.....	127
5.1.1	Plasma Characteristics.....	127
5.1.2	Signal-to-noise Consideration.....	127
5.2	Further Work.....	128
5.2.1	Ultra-trace Analysis Applications.....	128
5.2.2	Fundamental Mechanisms.....	129
References	130
Publications	138
Curriculum Vita	139