

Table of contents

Vorwort des Herausgebers	iii
Vorwort des Autors	v
Abstract	vii
Kurzfassung	ix
Table of contents	xi
Nomenclature	xiii
1 Introduction	1
1.1 Motivation	1
1.2 Objective and research approach	3
1.3 Outline of thesis	4
2 Fundamentals and current state of research	5
2.1 Efficient spark-ignition gasoline engines	5
2.1.1 Combustion anomalies	7
2.1.2 Knocking combustion and surface ignition	7
2.1.3 LSPI phenomenon	9
2.2 Principles of light-induced fluorescence	21
3 Investigation methodologies	23
3.1 Preparatory ex situ LIF investigations	24
3.2 Thermodynamic LSPI characterization	26
3.3 Optical LSPI characterization	32
3.4 LSPI key experiments	33
3.4.1 In situ LIF detection of lubricating oil and “High LSPI” fuel	33
3.4.2 Lubricating oil dosing and deposit/coffee injection investigations	35
3.4.3 Combustion chamber deposit characterization	37
4 Investigation environment and experimental engine systems	41
4.1 Investigation environment	41
4.2 Experimental engine systems	43
4.2.1 Optical engine system	45
4.2.2 Combustion chamber illumination systems	48
4.2.3 Endoscopic combustion chamber observation system	49

5 Results and discussion	51
5.1 Preparatory ex situ LIF investigations	51
5.2 Thermodynamic LSPI characterization	55
5.2.1 Generation of LSPI events: Operating media influence.....	56
5.2.2 Identification of key LSPI activity – EPS relations.....	57
5.2.2.1 Cooling water temperature influence on LSPI activity.....	59
5.2.2.2 Air-fuel equivalence ratio influence on LSPI activity	60
5.2.2.3 Fuel injection setup influence on LSPI activity	61
5.2.3 Distinctive LSPI activity pattern	66
5.2.4 Synthesized key LSPI mechanism information.....	68
5.3 Optical LSPI characterization.....	69
5.3.1 General combustion pattern and single LSPI event	70
5.3.2 Follow-up LSPI event – LSPI series	71
5.3.3 Ignition initiation of LSPI events	73
5.3.4 Interrelations of LSPI and deposit formation/detachment.....	74
5.3.5 Synthesized key LSPI mechanism information.....	76
5.4 LSPI key experiments	80
5.4.1 LIF detection of lubricating oil and “High LSPI” fuel.....	80
5.4.2 Lubricating oil dosing and deposit/coffee injection investigations	82
5.4.2.1 Lubricating oil dosing	82
5.4.2.2 Deposit/coffee injection	85
5.4.3 Combustion chamber deposit characterization.....	87
5.4.3.1 SEM-BSE and SEM-EDX analyses.....	88
5.4.3.2 TPO/TGA and ICP-OES analyses	91
6 LSPI root cause mechanism synthesis	93
6.1 Derived LSPI root cause mechanism.....	93
6.2 Further research recommendations	96
7 Summary and outlook	97
List of figures	101
List of tables	107
Bibliography	109
Publication summary	121