MASTER'S THESIS

A study on the composition and deposition mechanism of boron-silicon alloy films using ICP-AES, EDX and FT-IR techniques

Leu, Chun Lun Alan

Date of Award:
1991

A study on the composition and deposition mechanism of boron-silicon alloy films using ICP-AES, EDX and FT-IR techniques

Leu Chun-lun, Alan

A thesis submitted in partial fulfillment
of the requirements for the
degree of Master of Philosophy

September, 1991.

Hong Kong Baptist College
Hong Kong

ABSTRACT

Boron doped silicon films deposited at different substrate temperatures and at different gas ratio between diborane and silane gases were studied. Inductively coupled plasma atomic emission spectroscopy (ICP-AES) and energy dispersive x-ray spectroscopy (EDX) and Fourier transform infrared spectroscopy (FT-IR) experiments were carried out to study how the composition of the films depend on the substrate temperature and gas ratio of the reactants. The results showed that the silicon and boron contents of the films were affected by the partial pressures of silane and diborane gases and the substrate temperature during film growing. Also, it was found that the boron to silicon ratio in the film was close to that of the reactants gases when the film grew at low partial pressure of diborane gas, whatever the substrate temperature was. Furthermore, it was found that when the partial pressure of diborane gas was much higher than that of silane gas, the boron content in the film was found to increase much slower than it was expected, in agreement with Giling's suggestion of condensation of diborane molecules at high pressure of diborane gas. Results from Fourier transform infrared spectroscopy (FT-IR) experiments also showed the same result.

TABLE OF CONTENTS

ABSTRACT

DECLARATION

ACKNOWLEDGEMENTS

CHAPTER 1. INTRODUCTION 1

CHAPTER 2. BASIC THEORY 6
2.1 LOW PRESSURE CHEMICAL VAPOR DEPOSITION 6
2.1.1 BASIC SETUP OF A CVD SYSTEM 9
2.2 ICP-AES SPECTROMETER 12
2.2.1 INDUCTIVELY COUPLED PLASMA 14
2.2.2 DOUBLE MONOCHROMATOR 19
2.2.3 COMPUTER AND CONTROL PROGRAM 20
2.2.4 ADVANTAGES OF ICP-AES 21
2.2.5 DETECTION LIMITS 22
2.3 ENERGY DISPERSIVE X-RAY SPECTROMETER 23
2.3.1 PRINCIPLE OF THE ENERGY DISPERSIVE SYSTEM 24
2.3.2 COMPOSITION DETERMINATION 27
2.3.2.1 APPARENT CONCENTRATION 31
2.3.2.2 ZAF CORRECTIONS 32
2.4 FOURIER TRANSFORM INFRARED SPECTROMETER 38
2.4.1 INFRARED ABSORPTION OF A MATTER 39
2.4.2 BASIC THEORY OF THE MICHELSON INTERFEROMETER 40
2.4.3 HELIUM-NEON LASER 42
2.4.4 TRANSFORMING THE INTERFEROGRAM INTO A SPECTRUM 42

2.4.5 TRANSMISSION SPECTRUM OF THE SAMPLES 45

CHAPTER 3. EXPERIMENTAL 47
3.1 DESCRIPTION OF SAMPLES 47
3.2 EXPERIMENTAL PROCEDURE 53
3.2.1 MEASURING THE SAMPLE COMPOSITION BY ICP-AES 53
3.2.1.1 SAMPLE PREPARATION 53
3.2.1.2 ICP-AES SPECTROMETER EXPERIMENT 61
3.2.2 EDX EXPERIMENT 64
3.2.2.1 SAMPLE PREPARATION FOR EDX 64
3.2.2.2 EDX EXPERIMENT 65
3.2.3 FT-IR SPECTROMETER 71
3.2.3.1 SAMPLES PREPARATION FROM FT-IR 71
3.2.3.2 SPECTRUM COLLECTION 72
CHAPTER 4. RESULTS AND DISCUSSIONS 75
4.1 ICP-AES 75
4.2 EDX 85
4.3 FT-IR 94
4.4 DEPOSITION MECHANISM 105
CHAPTER 5. CONCLUSION 114

REFERENCES 116

VITA 119