PHOTOLUMINESCENCE SPECTROSCOPY AND FOURIER TRANSFORM INFRARED STUDY ON NANOSTRUCTURED POROUS SILICON

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MAY 2006

ACKNOWLEDGEMENTS

Assalamualaikum,

First of all, I would like to thank to mighty ALLAH who gave me strength and determinant to finish this project. Secondly, I would like to express my gratitude to my supervisor, En. Khairunnadim Bin Ahmad Sekak, for his kindness in helping me to carry out this project and for all his guidance throughout this period. Under his guidance and supervision, this project had been completed without much difficulty. All his advice have made me strong and he encouraged me to do and to think differently. I also like to thank Assoc. Prof. Dr. Saifollah Abdullah, as my co-supervisor for his support in completing my project. Also, my appreciation then goes to my beloved family far away that always gives support and help in many ways.

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ABSTRACT

PHOTOLUMINESCENCE SPECTROSCOPY AND FOURIER TRANSFORM INFRARED SPECTROSCOPY STUDY ON NANOSTRUCTURED POROUS SILICON

This project is to study the influences of the chemical etching by low concentration hydrofluoric acid on porous silicon (PS) surfaces using the photoluminescence spectroscopy (PL) and Fourier Transform Spectroscopy (FTIR). The PS surface was found to emit visible luminescence at room temperature. PL spectroscopy confirms the possibility of a quantum confinement effect by revealing the strong intensity and blue shift for the PS layer with chemical etching. We have characterized the FTIR peak of 620 cm^{-1} as the on- and near the surface regions of PS. The peak of 610 cm^{-1} is assigned for the Si - Si vibration mode in the bulk. The peaks present in the region of 2090 – 2140 cm^{-1} correspond to the Si – H, Si – H_2, and Si – H_3 stretching mode proof that the formulation of Hydrogen band which comes from HF. Also the large bands in the 1000-1200 cm^{-1} range is generally assigned to Si-O-Si stretching modes and to the presence of surface oxide species. IR absorbance studies on the PS layers indicated that the identity of the surface molecule is immaterial to the enhancement or degradation of photoluminescence.

CHAPTER 1

INTRODUCTION

Silicon, when anodized electrochemically or chemically in an HF-containing electrolyte, is etched in a manner which produces a sponge-like porous layer of silicon with pore dimensions that range from several microns in width to only a few nanometers. As well, a thin amorphous layer coats the walls in which are embedded small Si crystallites, a few nanometers in diameter. Though porous silicon (PS) had been studied since the mid-1950's, it was only during the past decade that a tremendous research activity was pursued following the observation of its remarkable room temperature luminescence. The interpretation of this phenomenon in terms of quantum confinement spurred scientific interest while the potential for significant applications in flat panel display technology and possibly in optoelectronics energized its technological development. Porous silicon's fortune swelled and receded many times as conflicting reports and opposing theories passed into the literature. The model which enjoys the broadest support focuses on the idea of a quantum confined nanostructure which is strongly influenced by the presence of radiative and non-radiative defect sites on its surface. However, a solid body of convincing evidence has been presented in support of a purely defect model as the origin of these optical phenomena. While early defect models considered the role of polymeric SiH_x and $Si(OH)_x$, the competing theory now expounds the role played by an oxygen defect site, common to the Si/SiO_2 interface, called a non-bridging oxygen