Properties of Porous Silicon in Ultra-Violet Spectrum

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Abstract – **In this paper the properties of porous silicon in ultra-violet spectrum and their probable application are observed.**

Keywords – **Porous silicon, ultra-violet spectrum, photoluminescence, spectrum shift.**

I. Introduction

Porous silicon is a form of the chemical element silicon which has introduced nanoporous holes in its microstructure, rendering a large surface to volume ratio of the order of 500 m2/cm3. Por-Si demonstrates optical properties based on porosity and the medium inside the pores. The effective refractive index of por-Si is determined by the porosity and refractive index of the medium inside the pores. If the refractive index of the medium inside pores is high, the effective refractive index of por-Si will be high as well. This phenomenon causes the spectrum to shift towards longer wavelength, so under ultraviolet beam por-Si will demonstrate red glowing.

II. Methods of obtaining of porous silicon

There are very different methods of obtainig of por-Si:

1) Anodization, when introducing pores in silicon is through the use of an anodization cell, which employs platinum cathode and silicon wafer anode immersed in Hydrogen Fluoride (HF) electrolyte. Corrosion of the anode is produced by running electrical current through the cell. It is noted that the running of constant DC is usually implemented to ensure steady tip-concentration of HF resulting in a more homogeneous porosity layer although pulsed current is more appropriate for the formation of thick silicon wafers bigger than 50 μm.

2) Stain etching with hydrofluoric acid, nitric acid and water. Porous silicon formation by stain-etching is particularly attractive because of its simplicity and the presence of readily available corrosive reagents; namely nitric acid (HNO_3) and hydrogen fluoride (HF). Furthermore, stain-etching is useful if one needs to produce a very thin porous Si films. A publication in 1960 by R.J. Archer revealed that it is possible to create stain films as thin as 25Å through stain-etching with HF-HNO_3 solution.

Besides there is another stain etching technique, discovered at the Microelectronics Department. It situates on etching in solution of HF-$NaNO_2$. This method can be used at low temperatures (approximately 300 K) and duration of etching is between 10 and 150 seconds, duration of process impacts thickness of por-Si layer. After etching simple must be washed in distilled water and dried with acetone.

There was discovered that different conditions during the fabrication of por-Si impacts its electrophysical properties differently.

As example: there was discovered that increasing of duration of etching durance will decrease the photosensitivity coefficient of por-Si, and, on the other hand increase the value of photocurrent.

III. Photoluminescence of porous silicon

Photoluminescence of porous silicon is observable at wavelengths ranging from the ultra-violet to the infrared. The photoluminescence is usually excited by a wavelength shorter than the emission wavelength, with excitation wavelengths typically lying between 260nm (for ultra-violet emission) and approximately 520nm[1].

General facts about photoluminescence of por-Si:

• All types of porous silicon show photoluminescence if porosity is sufficiently high (at least 50%) [1].

• Quantum efficiency of photoluminescence is 5% [2]

There was discovered that por-Si demonstrates photoluminescence if exposed to ultra-violet light. Moreover during exposure por-Si demonstrates shift of spectrum of light emission toward longer wavelength. For example, under exposure to ultra-violet light with wavelength of 385 nm, por-Si shows bright orange-red light emission of wavelengths from 650 to 750 nm [3].

IV. Conclusion

Ability of por-Si to demonstrate the spectral shift during photoluminescence under ultra-violet light is a prospective research area due to possible application of por-Si as a cover layer for photoelectrical converters for space systems.

References

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