Laser-Induced Selective Deposition of Pt on p-Silicon Wafers

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Abstract A process is described to selectively deposit Pt films from plating solution on p-silicon wafers. The p-silicon was locally irradiated using a Nd:YAG laser. At the irradiated area, the Pt film was formed. In this report, Pt films were obtained from three kinds of Pt plating solutions containing different legends. The effect of laser beam irradiation was studied. The quality of film was tested by SEMedXPSXP AES & QT2 techniques. The Pt deposits show ohmic contact with p-type silicon .On a certain condition, Pt will be deposited on ceramics. The local heating of solution-electrode interface under illumination has been attributed to the deposition process.
Keywords Pt plating , laser-induced deposition , p-Si

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Introduction

The semiconductor Si is the most important basic material for electronic parts in the modern electronic industry. The laser assisted deposition of metals on Si has also attracted more and more attention due to it's high selectivity maskless and rather simplicity. [1-6]. This technology has been extensively investigated recent years. Laser-induced selective deposition could proceed in a great variety of electrolytic solutions[7-11]. Hereinafter, we will expound the process of laser-induced platinum deposition in three different platinum plating solutions.

Experimental

A Nd:YAG laser((=532nm, pulse width=1ns, 75-150mJ/pulse,)was used as an exposure source. p-Si{111} crystal (8-13 Ω.cm) is used to be the base.

At the beginning, the base Si crystal must be pretreated like that (a) degreased by acetone, (b) flushed by distilled water, (c) immersed in 0.1mol.L^{-1} HF solution for 30 min. Then the Si was put into plating solution respectively. We studied of laser induced Pt deposition on p-SI in three different Pt plating solution such as (1) 10g.L^{-1} H_2PtCl_6, aqueous solution, (2) 10g.L^{-1} $K_2Pt(NO_2)_4$ aqueous solution, (3)8g.L^{-1} $Pt(NH_3)_2(NO_2)_2$, 10g.L^{-1} $NH_3.H_2O$(25%,mg. L^{-1}).

Results and discussions

UV spectrograms of those three kinds of plating solution are shown in Fig.1. The absorption of solution at 532nm is the least. In fact, we can't get the deposition unless irradiating at 532nm.

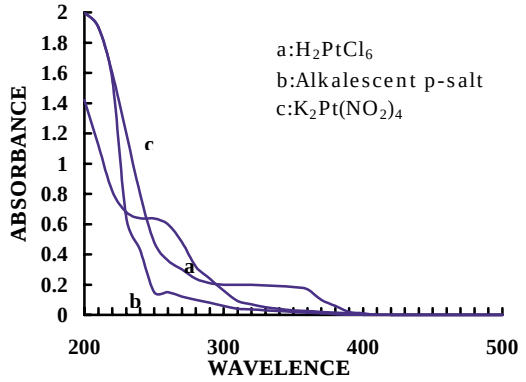

Figure 1 - UV Spectrogram of Solution

At the same irradiating condition (power, time, size of beam), the effects of different plating solution were investigated. The deposits obtained from three kinds of solution have large differences. The deposit obtained in H_2PtCl_6 solution is incompact as those obtained by electrodeposition (fig.2-1). In $K_2Pt(NO_2)_4$ solution, the deposits obtained disperse on Si surface well, though they are small (fig.2-2). Among of them, the quality of deposits obtained from the third solution ($Pt(NH_3)_2(NO_2)_2$) is the best (fig.2-3). In this respect, the distribution of deposit was studied by EDX (fig.2-4).

Figure 2-1 – SEM Picture of Deposition in H_2PtCl_6 Solution

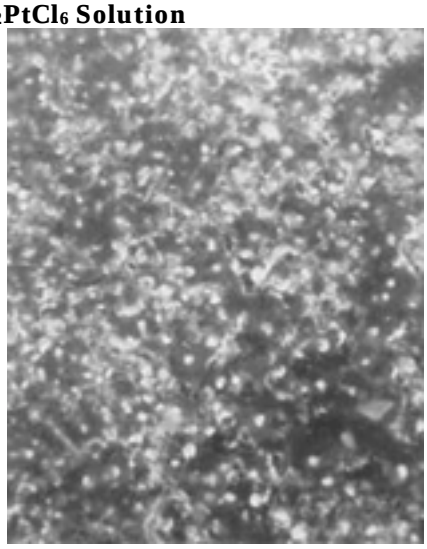

Figure 2-2 – SEM Picture of Deposition in $K_2Pt(NO_2)_4$ Solution

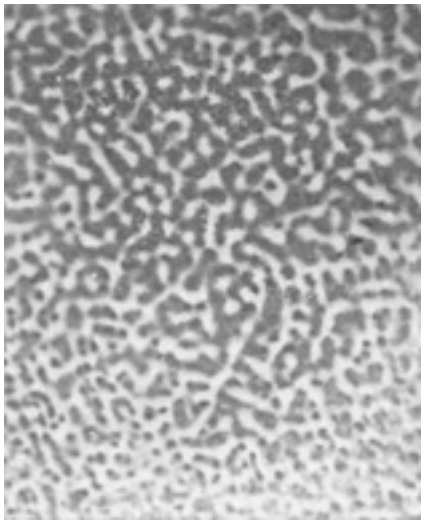

Figure 2-3 – SEM Picture of Deposition in $Pt(NH_3)_2(NO_2)_2$ Solution

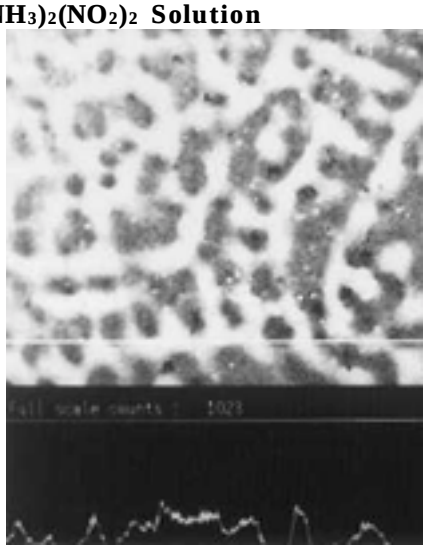

Figure 2-4 – EDX of Deposition

Subsequent studies on deposit obtained from alkalescent p-salt solution with XPS method show the main component is platinum carbon, oxygen, silicon, and so on. (fig 3-1). It was found from XPS spectra that

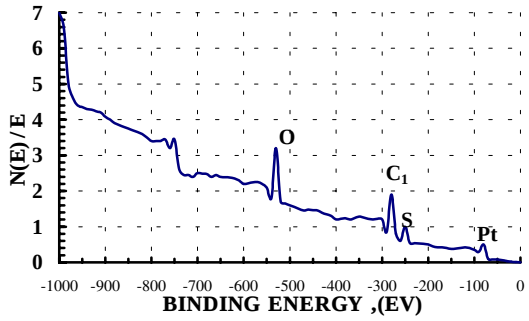

Figure 3-1 – XPS Picture of Deposition in $Pt(NH_3)_2(NO_2)_2$ Solution

the platinum obtained exists in atomic state(fig 3-2).The data of AES analysis, show the same components in the deposits obtained. Along with the irradiation of electron beam, the intensity of special peaks belonging to carbon, oxygen, nitrogen are descending. All results show the platinum is the main component of deposition.

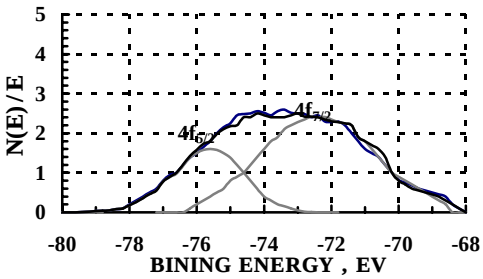

Figure 3-2 – Simulation of Platinum peak

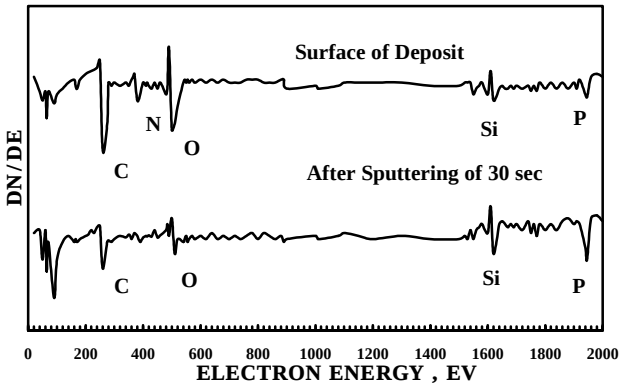

Figure 3-3 – AES Picture of Deposition

The electronic conduct between platinum deposition and the silicon base was studied (fig.4). Holding the linear relationship between current and voltage, in the high voltage region, shows this technique could be used to form an ohm-conduct in manufacturing of semiconductor parts.

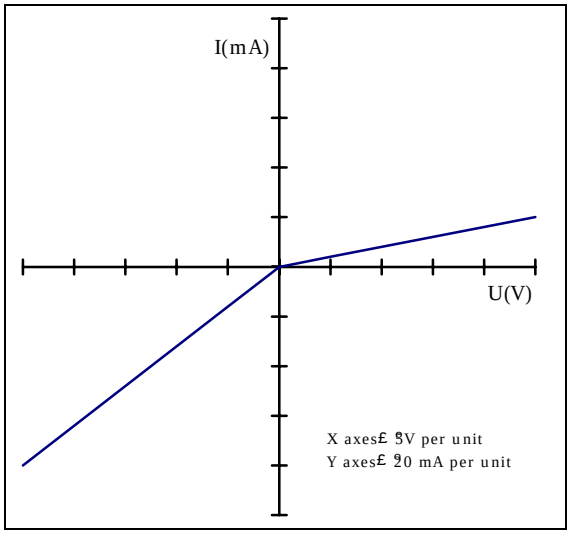

Figure 4 – Relationship between Current and Voltage

The process of laser-induced deposition on semiconductor may contain two steps [12] (1) photo catalysis: photoelectron is produced by irradiation. The selective area becomes the depositing center. (2) Thermal decomposition reaction.

Conclusion

In the $Pt(NH_3)_2(NO_2)_2$ solution, we can obtain good deposition with Nd:YAG laser. The deposition was constituted of atomic platinum mainly. The contact between surface and basis show good ohmic character.

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