Electrochemical Deposition of Nickel Thin Films Onto Monocristalline Silicon

A. Chenna[1], N. Benbrahim[1], A. Kadri[1], Y. Dahmane[1,2] and Y. Belaroussi[3]
[1]*Laboratoire de Matériaux Électrochimie & Corrosion LaMEC de l'Université M. Mammeri*
[2]*Laboratoire Louis NEEL CNRS GRENOBLE, France*
[3]*C.D.T.A., Alger*

Thin magnetic films deposited directly onto silicon enable the linkage of silicon technology with magnetic properties. Magnetic thin films are a promising material in the developing technology of high density storage devices. The possibility of metal deposition directly on silicon opens up the opportunities of signal processing in a single device [1, 2]. Metallic films are generally produced by physical methods such as PVD, CVD and others. An old technique such as electro-deposition appears as a new alternative to obtain deposited films with some advantages: room temperature deposition, relative simplicity and low cost. The electro-deposition of metals directly on n-type silicon without a seed layer is possible when the silicon is sufficiently conductive to allow electro-deposition directly onto it. Electro-deposition on a semiconductor is quite different from that on metal. When a semiconductor electrode is introduced in an electrolyte, a space charge layer is formed in the semiconductor. In a metal electrode, this space charge is so thin that it can be neglected because of the high donor density. On a semiconductor electrode, an applied potential does not drop only in a double layer at the solid – liquid interface as on metals, it also drops along the space charge layer in the solid [3, 4]. In the present work, we present results concerning the electrochemical conditions suitable for plating Ni thin films onto n-Si (100). The energy levels of the interface n-Si (100)/Ni^{+2} were determined from Mott- Schottky plots. The deposits were prepared at various current densities from sulphate bath containing metallic ions and boric acid. An aspect related to the deposition process was investigated by cyclic voltammetry. The film structure and morphology were examined by X-rays diffraction and scanning electron microscopy. Typically, thin compact metallic films were obtained.

The electro-deposition of metals onto semiconductors is strongly dependent on the relative position of the equilibrium potential of the redox couple in the solution with respect to the flat band potential of the semiconductor [4,5,6]. In this work, the flat band potential and the donor density were determined from the Mott-Schottky plot (Fig.1) for n-Si in the sulphate bath. A flat band potential of -0.68 V was obtained. From the slope ($2/eN_D \varepsilon \varepsilon_0$), the donor density of 3.9 x 10^{14} was calculated.

The volammograms for the gold (Au) electrode in the sulphate bath and for n-Si electrode in the same bath are shown in Fig. 2. It can be seen that the reduction potential of Ni on Au electrode begin at -0,55V (point A), whereas on the Si electrode, it begin at -0.94 V (point B).

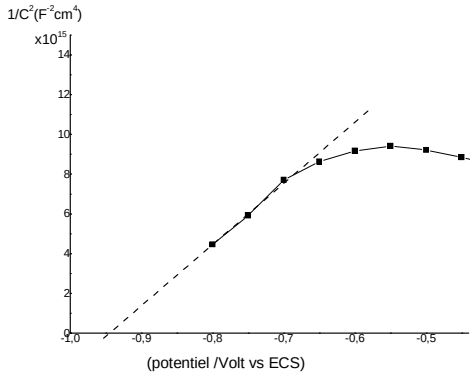

Fig.1. Mott- Schottky plots for n-Si in thelating bath solution in the dark. The mesuring frequency was 8,690 kHz,and the amplitude 10 mV.

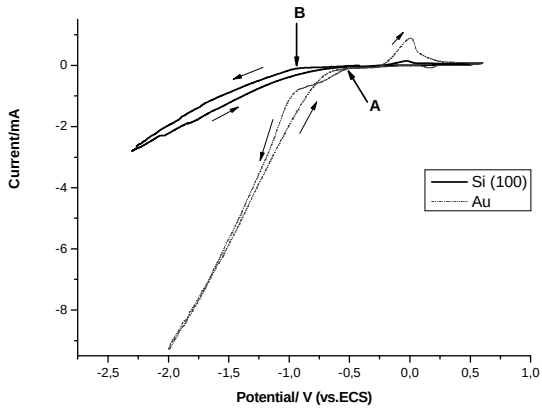

Fig.2. Cyclic voltammograms of Si(100) and Au electrodes in the plating solution. The scan rate is 20mV/s

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