INFLUENCE OF ORGANIC ADDITIVES ON THE ELECTRODEPOSITION OF Cu/Co MULTILAYERS

E. CHASSAING
Centre d'Etudes de Chimie Métallurgique-CNRS,
15 rue Georges Urbain, 94407 Vitry-sur-Seine, France

The electrodeposition of Cu-Co multilayers was investigated in the presence of two additives, sodium dodecyl sulfate (SDS) and saccharin [1, 2]. Cyclic voltametry, steady-state polarization, impedance and potential pulses were carried out, using a quartz crystal microbalance. The magnetoresistance was measured. The experimental conditions have been already described [3].

Cyclic voltametry shows that the additives do not markedly affect the discharge of copper, but they have a strong effect on that of cobalt. Saccharin inhibits the deposition whereas SDS has a depolarizing effect.

Steady-state polarization - In the presence of saccharin, the polarization curve is shifted towards negative potentials whereas addition of SDS has a slight effect (Fig. 1). Two different slopes are observed depending on the polarization, indicating a two-step discharge of the Co(II) species as for nickel [4].

Electrochemical impedance - (Fig. 2). In the basic electrolyte or in the presence of SDS, the double layer capacitance is rather large. In the presence of saccharin, it is markedly decreased, probably as the result of a blocking adsorption of saccharin [5]. The $R_t.i$ product of the charge transfer resistance and the current density, increases with polarization from 45 to 70 mV. The impedance plots exhibit, at low polarization, in addition to the high-frequency capacitive feature, a medium-frequency inductive loop, whose characteristic frequency increases exponentially with polarization. This behavior is quite similar to that observed for the discharge of nickel [4]. As for nickel, this feature is attributed to the two-step discharge of cobalt via an intermediate adion

$$Co(II) + e <=> Co(I)_{ads} \quad (1)$$

$$Co(I)_{ads} + e -> Co \quad (2)$$

These reactions are coupled to the hydrogen evolution reaction, written as the global reduction of the protons:

$$2\,H^+ + 2e -> H_2 \quad (3)$$

Reaction 1 is considered as a reversible process to account for the increasing $R_t.i$ product with polarization. In the presence of SDS, the kinetics of these reactions are only slightly modified. In the presence of saccharin, a blocking adsorption occurs [5], which inhibits the discharge of cobalt.

Potential Pulses - Cu-Co trilayers were prepared at E_1 = -0.4V/sce and E_2 at –1V/sce, using the EQCM [3]. The frequency shifts were corrected for the mass distribution using the model of Kelly et al [6]. Hydrogen evolution is the main reaction at the beginning of cobalt deposition. This was confirmed by in-situ magnetization measurements [7]. The partial curves for hydrogen evolution are only slightly affected by the additives, whereas the curves for cobalt deposition depend strongly on the presence of the additives (Fig. 3): SDS increases the deposition rate of cobalt whereas saccharin inhibits it.

Magnetoresistance measurements were carried out for Cu-Co multilayers deposited on ITO glass (t_{Cu}: 4.5nm, t_{Co}: 0.8nm). The GMR is 9±0.5% in the presence of both additives, whereas it is 25% for multilayers deposited from the basic electrolyte as shown for other additives [8].

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Fig. 1: Steady- state polarization curves

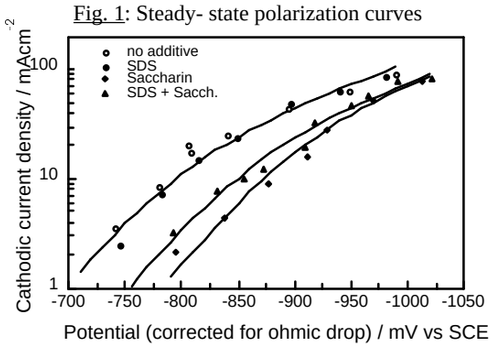

Fig. 2 : Impedance plots recorded for 15 mAcm^{-2}

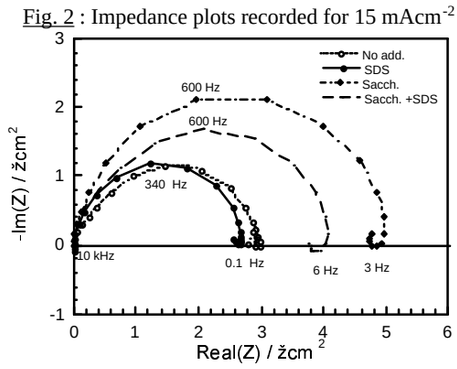

Fig. 3: Transient polarization curves for Co deposition