Hardness and XRD Investigations of Ni/Cu and Co/Cu Multilayers Prepared by Electrodeposition

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INTRODUCTION

Metallic multilayers have been the subject of intensive studies. They have very interesting properties, which are unattainable in bulk materials. The primary interest is in magneto-electrical properties (GMR effect)[1] with the secondary goal of improving the tribological properties of the surface[2]. Among the different methods, the electrochemical deposition is one of the most promising. It is of low cost and can deliver high quality structures, when applied to prepare metallic multilayers [3].

EXPERIMENTAL

In this work a computer controlled electrochemical method for obtaining metallic superlattices is presented. We used the potentiostatic method from the single electrolyte bath, based on sulphamate (Ni) and sulphate (Co, Cu). By this method we have obtained Cu/Ni and Cu/Co superlattices. We used as the substrates: polycrystalline copper foil and n–dopped Si (100) wafers. Additionally Cu, Ni, Au thin films evaporated onto Si wafers were used as a buffer layer. The current transient during the deposition on different substrates was collected and analysed by our original software. X-ray diffraction method was used for the structural investigations (both substrate and deposit) and evidence of layered (or not) deposit structure. The hardness of the composite (substrate Cu or Si + multilayer) was measured using the Knop indenter with 10 g load.

RESULTS

The production of a well defined multilayered structure was confirmed (by XRD) for Ni/Cu multilayers grown onto Si substrate without any buffer layer (Fig. 1a) and with 50 nm evaporated copper buffer (Fig. 1b). In the case of deposition of Ni/Cu multilayers on other substrates only the ML (111) and (200) main peaks were visible. The hardness of the composite (substrate+deposit) deposited onto a polycrystalline copper substrate (about 100 HK_{10}) had values between 110 – 232 HK_{10}. In most cases this was twice as much than for the copper substrate (100 HK_{10}). The changes in the hardness were observed as a function of the lambda period value as well as total thickness of the deposit. The hardness of the Ni/Cu multilayers deposited onto Si substrates with (or not) different buffer layers is presented in table I. The hardness of the multilayers deposited on to Si substrates had lower values than hardness of Si. The sample with the highest hardness was that containing 100×(3 nm Ni + 2 nm Cu) deposited onto Si substrate with Ni buffer layer.

CONCLUSION

In this work the possibility of deposition of the metallic multilayers onto different kind of the substrates have been checked. The electrochemical process and structure of the deposits as the function of different kind of substrates have been investigated. The hardness results, especially for deposition onto polycrystalline cooper foil, are very promising for improving of the wear resistance.

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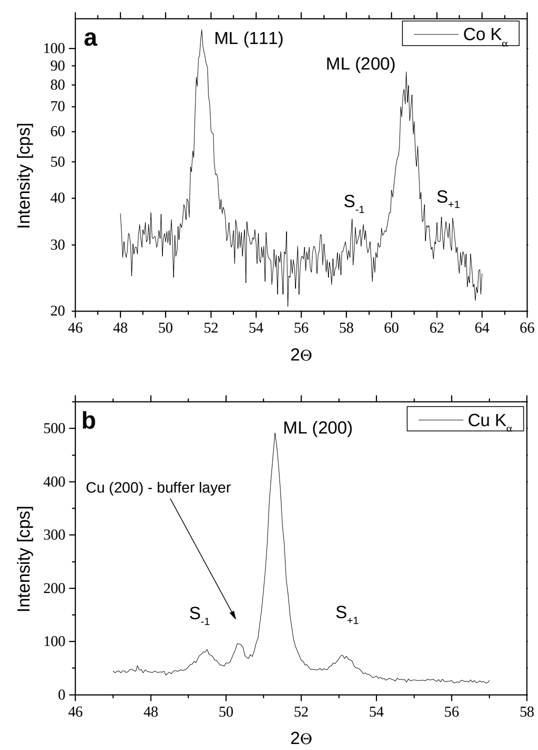

Fig. 1. X-ray patterns for (a) 200×(2 nm Cu + 3 nm Ni) deposited directly onto Si(100), and (b) 200×(2.4 nm Cu+2.7 nm Ni) deposited onto Si(100)+Cu buffer layer samples.

TABLE I
The hardness of the Ni/Cu multilayers deposited onto Si substrates with (or not) different buffer layers.

Substrate	Buffer layer	Composition	Hardness [HK_{10g}]
Si	-	200×(3 nm Ni+1 nm Cu)	531
Si	-	200×(3 nm Ni+1.5 nm Cu)	592,3
Si	-	200×(3 nm Ni+2 nm Cu)	677,7
Si	Pt	100×(3 nm Ni+2 nm Cu)	699,7
Si	Ti	100×(3 nm Ni+2 nm Cu)	552,4
Si	Cr	100×(3 nm Ni+2 nm Cu)	371,1
Si	Ni	100×(3 nm Ni+2 nm Cu)	715,7