

Corrosion resistance of CoSm thin films protected by Si₃N₄

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The ever-increasing need of data storage industries requires materials with high anisotropy in order to successfully cope with requirements for thinner magnetic layer and smaller grain size. Co-Sm alloys are very attractive candidates proving high coercivities and good magnetic stability when deposited at room temperature[1]. In addition to these attractive magnetic properties, a good magnetic material has to have an adequate wear and corrosion resistance. This requirement is usually accomplished by coating the magnetic layer with an overcoat based on either carbon or silicon. Recently has been reported [2] that a layer of about 8 nm should provide adequate protection against degradation of the magnetic properties of Co-Sm thin films. Since the mechanism of various reactions that take place during the deterioration of a material subjected to aggressive environments is electrochemical in nature [3], we studied the corrosion behavior in aqueous solutions containing 0.25 M of either NaCl or Na₂SO₄ at various pH's.

The samples were deposited by DC and RF (for Si₃N₄) sputtering without intentional heating, on glass substrates, with a base pressure of less than 3x10⁻⁷ Torr. The targets have a nominal composition of Co₇Sm₂, Cr and Si₃N₄, respectively. The samples have a layered structure with the following configuration, starting from the glass substrate: Cr(60 nm)/CoSm(12 nm)/Si₃N₄(x nm), with x = 2 to 8 nm. Argon was used as a sputtering gas. The deposition conditions in terms of pressure/power density were as follows: 5 mTorr / 16 W x cm⁻² for the underlayer, 20 mTorr / 8 W x cm⁻² for CoSm and 3 mTorr / 8 W x cm⁻² for Si₃N₄. Measurements were carried out in a typical three electrode cell (working electrode: sample, reference: SCE, and counter electrode: platinum sheet). An EG&G Potentiostat/Galvanostat was used for data collection and data analysis. After stabilizing the sample at its open potential (E_C) for about 30 minutes, it was polarized from 300 mV below E_C towards anodic potential at a scan rate of 5 mV/s.

In Fig.1 is presented a comparison of potentiodynamic scans for Co, Co-Sm and Co-Sm/Si₃N₄ acquired in the same condition. While Co shows an almost unhindered dissolution, both unprotected and protected Co-Sm films show a different behavior as well as an anodic shift in potential. The influence of pH was studied by acquiring the potentiodynamic curves of samples protected by 10 nm of Si₃N₄, under similar conditions for both electrolyte solutions (0.25 M NaCl and Na₂SO₄). Passivation region is observed at pH = 4 for both solutions, as exemplified in Fig. 2, only for the case of NaCl. Both electrolytes are quite aggressive, NaCl more so than Na₂SO₄. This was confirmed also by magnetic measurements which showed that the magnetic layer was completely corroded in NaCl (both pH's) and Na₂SO₄ at pH = 4, while at pH = 11, a 60% reduction in the magnetization is observed. Furthermore, the influence of the overcoat thickness was studied and the results obtained in the case of Na₂SO₄ solution are shown in Fig. 3. As can be observed, the thickness range studied does not show a considerable improvement on corrosion resistance (a even small anodic

shift was observed in the case of NaCl solution). This suggests that chemical reactions are most relevant in determining corrosion resistance in these electrolytes.

Although no definite improvement of corrosion resistance with increasing thickness of Si₃N₄ overcoat, potentiodynamic experiments show the beneficial effect of the overcoat on the thermodynamic properties of the system (increase in E_C with about 100 mV).

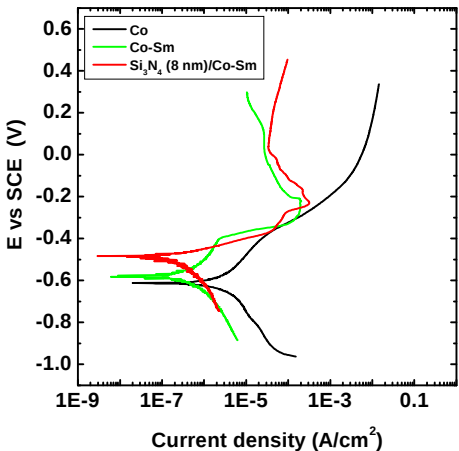


Fig.1. Comparison of potentiodynamic scans for Co, Co-Sm and Co-Sm/Si₃N₄ in 0.25 M NaCl, pH=4.

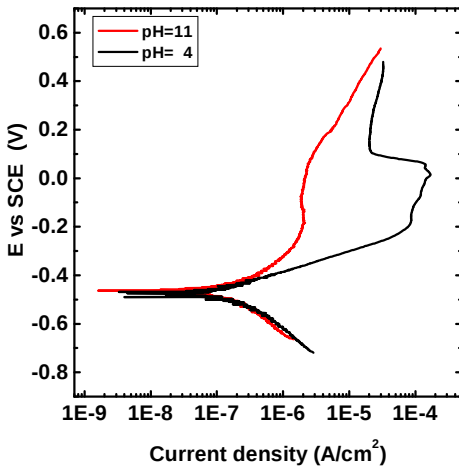


Fig.2. Influence of pH on the potentiodynamic curves for Co-Sm/Si₃N₄ (10 nm), in 0.25 M NaCl.

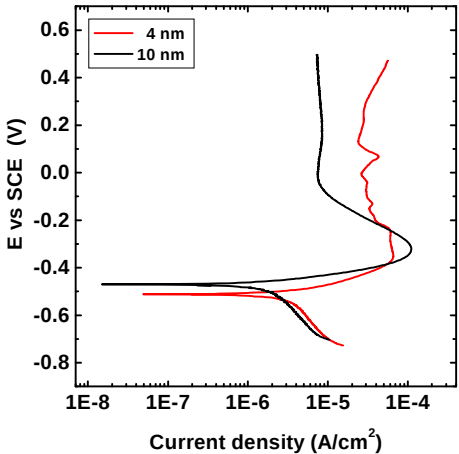


Fig.3. Influence of overlayer thickness on the potentiodynamic curves for Co-Sm/Si₃N₄, in 0.25 M Na₂SO₄, pH=4.

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