NANOCRYSTALLINE AND AMORPHOUS RARE EARTH – IRON GROUP ALLOY ELECTRODEPOSITS

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INTRODUCTION

There is considerable interest and research on the deposition of magnetic thin films containing rare earth (RE)-iron group (IG) alloys. The RE-IG alloys exhibit good hard magnetic, magneto-optical and giant magnetostriction (GMS) properties, which potentially can be applied to data storage and micro and nano electromechanical systems (MEMS and NEMS). These alloys have been deposited using vacuum (PVD, sputtering, e-beam evaporation) and spin melting techniques [1].

This paper reports on our continuing work on the aqueous electrodeposition of RE-IG alloy thin films with individual rare-earth elements (e.g., Ce, Nd, Sm, and Gd) and combinations of rare-earths (mischmetal). The effects of solution chemistry and deposition conditions on deposit composition, structure, and magnetic properties are investigated.

EXPERIMENTAL

Individual RE salts of La, Ce, Nd, Sm, Gd and mixtures (mischmetal) were studied. A typical solution composition was 0.9 M RE metal ions, 0.12 M IG metal ions, 0.36 M complexant, 1.00 M NH_4 salt. Brass was used as a substrate; iron group metals were used as anodes.

The film compositions were determined by EDX and chemical analysis. Magnetic properties were determined using a vibrating sample magnetometer. Microstructures were examined with scanning electron microscopy and X-ray diffraction with Cu K_α radiation used for the identification of the existing phases and grain sizes.

RESULTS AND DISCUSSION:

Figure 1 shows the dependence of magnetic saturation on the deposit RE content. The electrodeposited RE-Co alloys follow the same trends as the theoretically predicted, RE_2Co_{17} and $RECo_5$ bulk compounds and sputtered thin films.

X-ray analysis was performed to determine the effect of RE on phase formations and microstructure of the electrodeposited RE-IG alloys. Figure 2 shows a typical X-ray diffraction pattern of electrodeposited RE-IG alloys indicating that the film is nanocrystalline or amorphous.

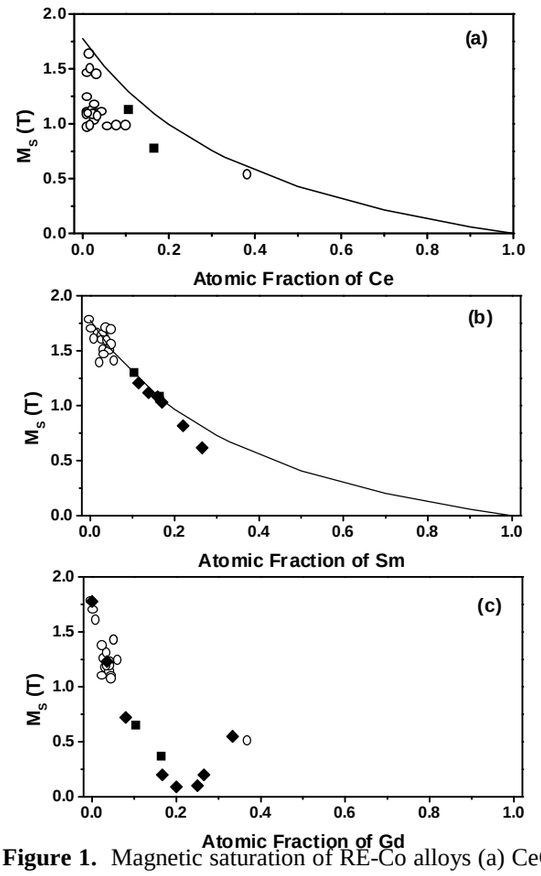

Figure 1. Magnetic saturation of RE-Co alloys (a) CeCo, (b) SmCo, (c) GdCo: ○ Electrodeposits, ■ bulk compounds (Co_2RE_{17}, $CoRE_5$), ◆ sputtered films, _____ theoretical prediction.

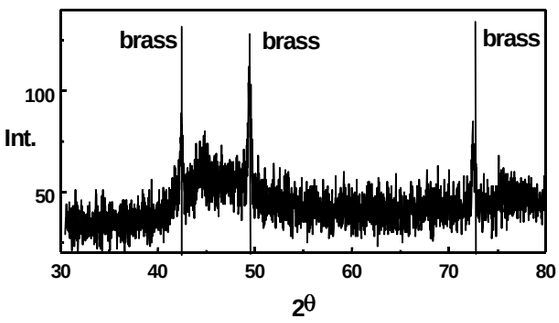

Figure 2. XRD patterns of as electrodeposited CoSm thin films (5.8 at. % of Sm): (brass substrate peaks).

ACKNOWLEDGMENT

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REFERENCES

1. G. J. Long and F. Grandjean, "*Supermagnets, Hard Magnetic Materials*". Kluwer Academic Publishers (1991).