Electroless plating of rhenium base alloys with nickel, cobalt and iron

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Rhenium (Re) is a refractory metal that has a unique combination of properties that makes it a promising candidate material for variety of applications, which demand high-temperature strength, wear, and erosion resistance [1]. Unlike other refractory metals, Re does not form carbides. That is why Re coating is a potentially attractive protective material for different types of carbon substrates. Formation of Re-based alloy coatings has been reported in the literature for chemical vapor deposition (CVD) and electroplating [2]. In this study, we propose to use electroless plating in order to form Re-based coatings. The ability to form very thin films (< 100 nm) on conductive and non-conductive substrates inside of holes, recesses and non-line-of-sight surfaces makes electroless plating an ideal deposition process in micro- and nano-technologies.

Pure Re films cannot be deposited from electroless plating baths using perrhenate salt, ReO_4^-. In our previous study, nickel was added to the bath in order to start the induced co-deposition of Re. Re-Ni alloys with high rhenium content (> 75 at %) were obtained and studied [3]. In this work, an equivalent bath composition that was used for Re-Ni alloy deposition was applied to co-deposit other iron-group metals with Re.

All deposits were formed by electroless plating on sputtered Cu (50 nm)/ Ti (10nm) /glass substrate. Films of high quality and with high Re-content were obtained. The Re-content decreased from 77 at.% to 65 at.% and to 60 at.% for Re-Ni, Re-Co and Re-Fe alloys, respectively. The deposition rates for Re-Ni, Re-Co and Re-Fe were evaluated and compared, as illustrated in Fig. 1. The film deposition rate was reduced from 26 to 8 and to 2 $nmmin^{-1}$ for Ni-Re, Co-Re and Fe-Re alloys, respectively.

The layers were deposited also on activated carbon, as shown in Fig.2. Activated carbon has been widely used as an adsorbent, a catalyst support, and an electronic material due to its high surface area.

The electroless process of co-deposition of Re with other iron-group metals, such as Ni, Co and Fe was studied at open-circuit potential as well as by mixed-potential measurements.

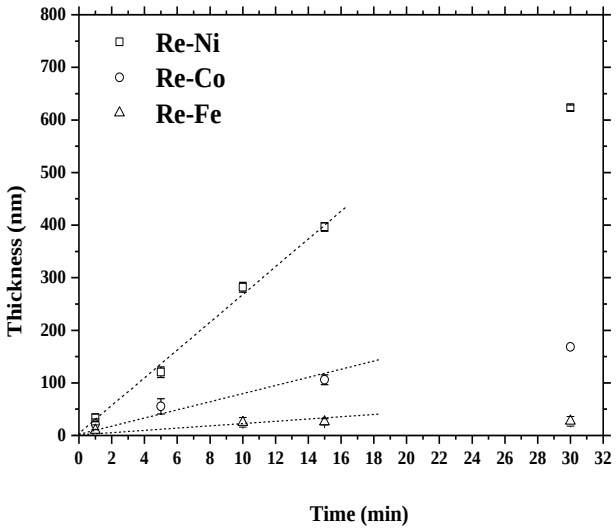

Fig. 1 The thickness of Re-Ni, Re-Co and Re-Fe layers from a solution containing 3.45 mM iron-group salt, 34.5 mM ReO_4^-, 170 mM sodium citrate, 100 mM DMAB.

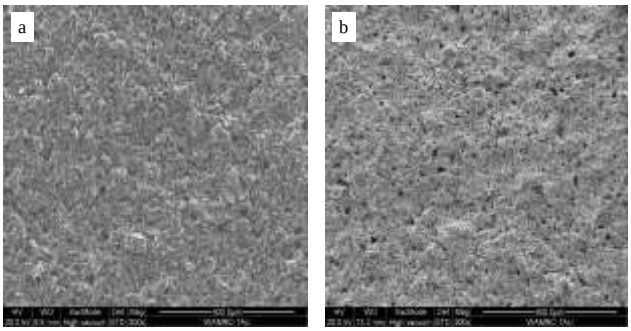

Fig. 2 SEM image of: (a) activated carbon substrate, and (b) Re-Ni film deposited on activated carbon substrate.

References

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