

Electrodeposition of Mn-Zn and Mn-Cu Alloys From Sulfate Solution Containing Complexing Additives

D.Gogoli, G.Tsurtsumia

Department of Electrochemistry and Electrometallurgy, R.Agladze Institute of Inorganic Chemistry and Electrochemistry of I. Javakhishvili Tbilisi State University, Tbilisi,Georgia

E-mail: davit.gogoli@tsu.ge

Manganese alloys with copper, zinc, cobalt, and nickel are characterized by high corrosion protective properties and their technical and economic efficiencis are equal to known protectors prepared on the bases of aluminum and magnesium.

We obtained mirror-like coatings based on a nanocrystalline, globular-shaped Mn-Zn alloy with a high Mn content (97-98%) from a sulfate-ethylenediaminetetraacetic acid disodium salt bath in the presence of sodium selenate (NS) as an additive. Electrolyte: 5 g/l $ZnSO_4 \cdot 7H_2O$, 10 g/l EDTA, 58 g/l $MnSO_4$, 68 /l $(NH_4)_2SO_4$, 0.33 g/l NS, pH 3-5.5; t=30^{0}C; current density 0.1 - 0.175 mA/cm^2; plating time τ=15min; coating composition: 97.5 - 98.5 wt % Mn, 2.5-1.5 wt % Zn; and current efficiency 45.2 - 51.7%. The nanocrystalline electrodeposited Mn-Zn alloy coating (Fig.1), featured broad and poorly defined diffractograms, X-ray diffractograms, which corresponded to a cubic α-Mn crystal structure (Fig.2).

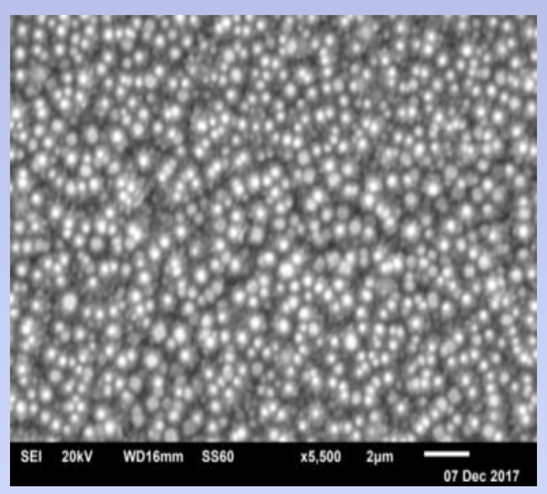


Fig.1. SEM micrograph of a Mn-Zn (wt 98% Mn) alloy electrodeposited at 0.1A·cm^{-2} for 15min

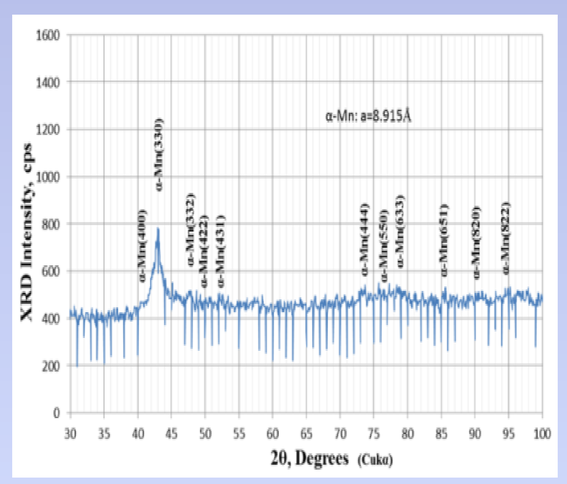


Fig.2. X-Ray diffractogram of a electrodeposited Mn-Zn alloy (98%wt Mn).

Silvery, fine crystalline, solid and nonporous coatings of Mn-Cu alloy are obtained only at high cathodic current densities ($i_k \geq 37.5$ A·dm^{-2}) and within pH 6.5-7.5. Current efficiency was 42% ($i_k = 37.5$ A·dm^{-2}, pH 6.5, t=30^{0}C).

In the alloy, average content of manganese was 93%, copper 7% (Fig.3). X-ray diffraction pattern of the alloy shows the BCT (body centered tetragonal) γ-Mn solid solution phase with copper (Fig.4).

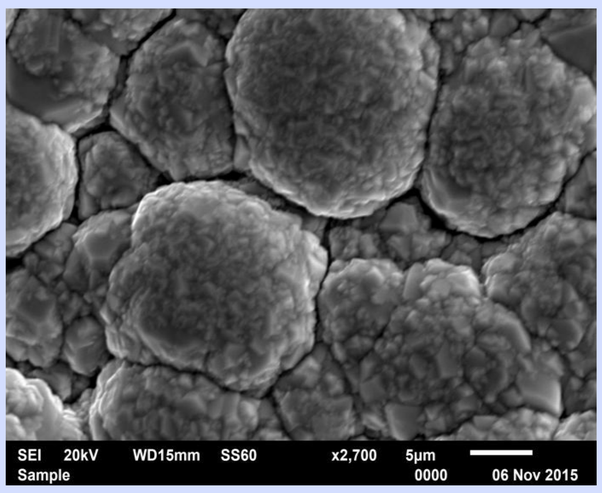


Fig.3. SEM micrograph of Mn-Cu alloy (electrolyte:0.3 mol/l Mn^{2+} + 0.6 mol/l $(NH_4)_2SO_4$ +5.10^{-3}mol/l Cu^{2+} +0.1 mol/l Na_3Cit +0.1 mol/l EDTA; pH 6.5;i_k = 37.5 A/dm^2; *t* = 30 °C; *τ* = 20min

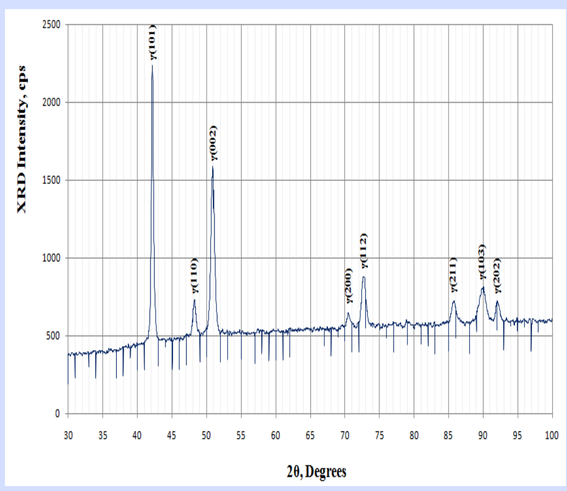


Fig.4. X-Ray diffractogram of a electrodeposited Mn-Cu alloy

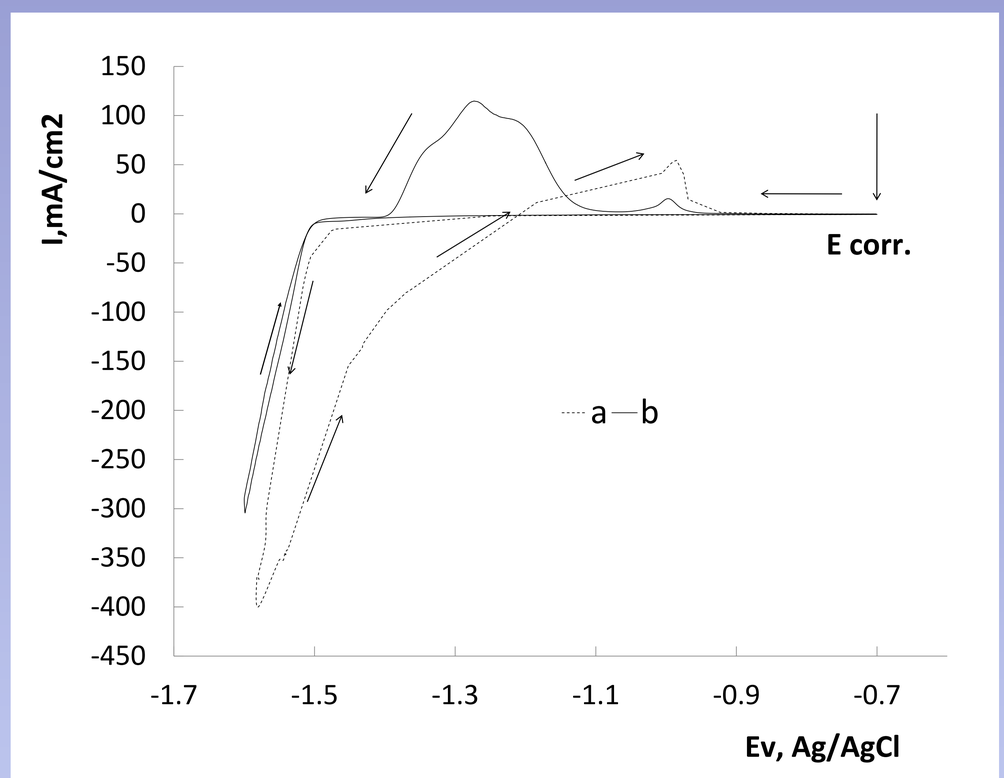


Fig.5. Typical cyclic voltammogram obtained on carbon steel from aerated basic solution: 5 g/l $ZnSO_4 \cdot 7H_2O$, 10 g/l EDTA, 58 g/l $MnSO_4$, and 68 g/l $(NH_4)_2SO_4$; pH 3.5;t=30^{0}C; without NS additive (a) and with 0.33g/l NS additive (b); scan rate 10mV·s^{-1}.

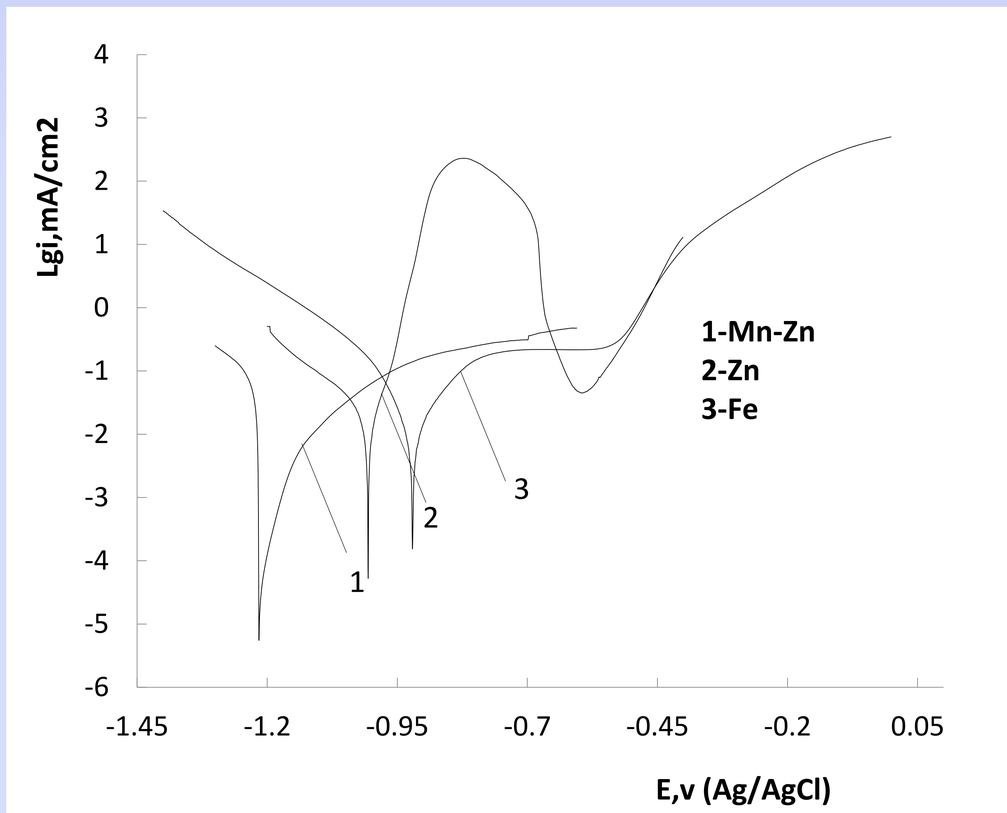


Fig.6. Tafel polarization curves obtained for Mn-Zn alloy (a), for Zn deposited on steel (b) and carbon steel in 0.5 M NaCl solution (pH 6.0);. t=30^{0}C; v =10mV s

Acknowledgement

This work was supported by Shota Rustaveli National Science Foundation (SRNSF) (grant number YS-2016-18 "Electrochemical Synthesis of Corrosion Resistant Manganese Alloys Coating").