SAVE THE DATE – VIRTUAL EVENT
4th Postgraduate Research Symposium on Ferrous Metallurgy, Tuesday 23rd February 2021

The latest academic thinking on Ferrous Metallurgy

Effect of environmentally friendly additives on Zn-Mn alloys morphology and structure

Nouha Loukil [1], Mongi Feki

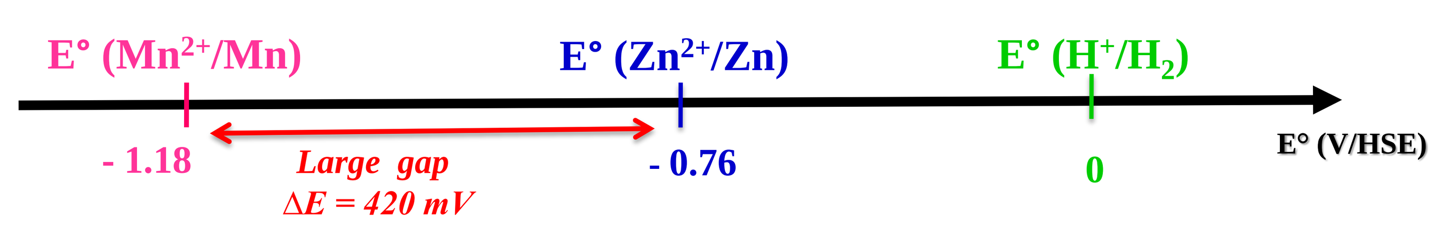
[1] Laboratory of Materials Engineering and Environment, ENIS-Tunisia, University of Sfax, nloukil87@gmail.com

Abstract

Pure Zn coating commonly used for the protection of steel is not sufficient in some industrial applications due to its high dissolution rate. There is a growing interest in Zn-Mn coatings owing to the highest corrosion resistance compared to that of pure zinc coatings. In this work, a novel additive based on Octylphenylpoly(ethyleneglycol)$_{10}$ and 3-hydroxybenzaldéhyde 3-HBA was investigated in Zn-Mn electrodeposition on steel from chloride bath. These additives inhibit Zn deposition in favor to that of Mn owing to their adsorption on The surface cathode. Thus, Zn-Mn alloys were successfully electrodeposited with suitable properties. The Mn content reaches around 20%. SEM data reveal that Zn-Mn exhibits fine morphology.

Major problems of Zn-Mn co-deposition

1. **Large gap between Zn and Mn deposition potentials :**



2. **Hydrogen evolution reaction inhibits Mn co-deposition with Zn**

3. **Mn-rich alloys require high current densities leading to powdery alloys**

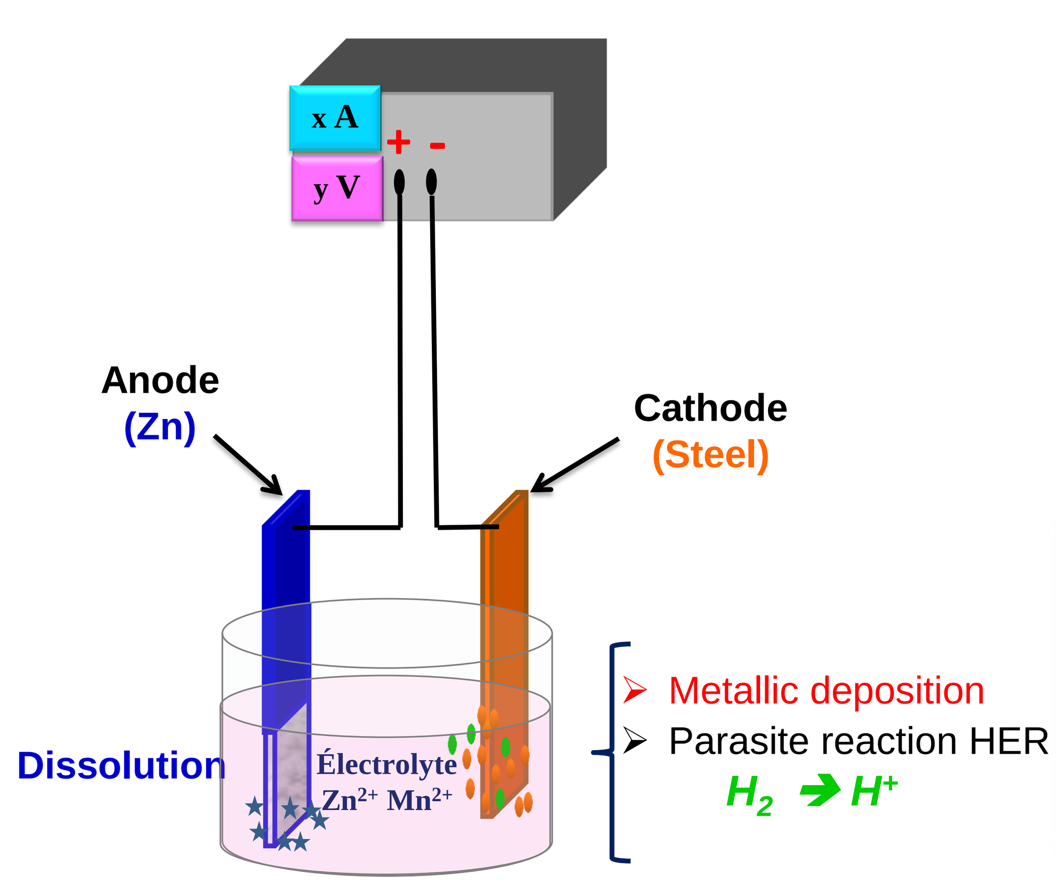
Use of **complexing agent specific for Zn^{2+} reduction** to ensure Zn-Mn co-deposition. Stringent environmental concerns have restricted the complexing agent due to **serious problems related to wastewater treatment**.

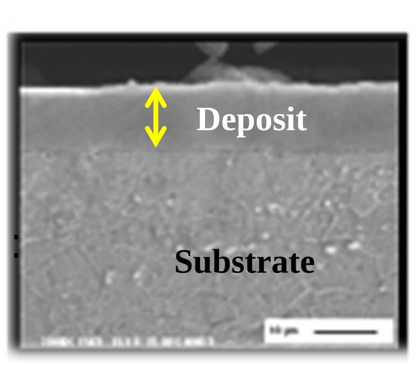
Experimental details

Experiments were carried out from an acidic chloride bath S_{Zn-Mn}

Chemical constituant	KCl	H_3BO_3	$ZnCl_2$	$MnCl_2$
Concentration (mol/l)	3.2	0.4	0.4	0.4

Bulk electrolysis



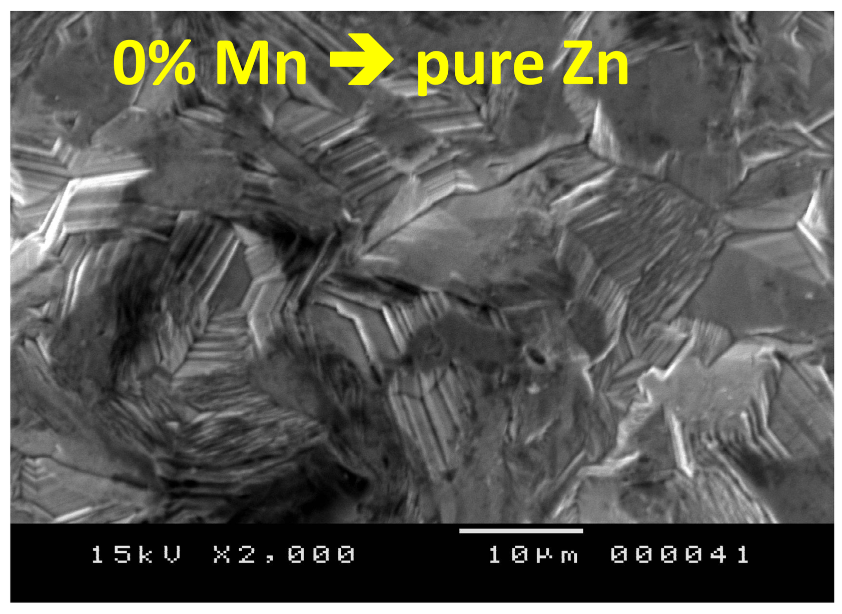


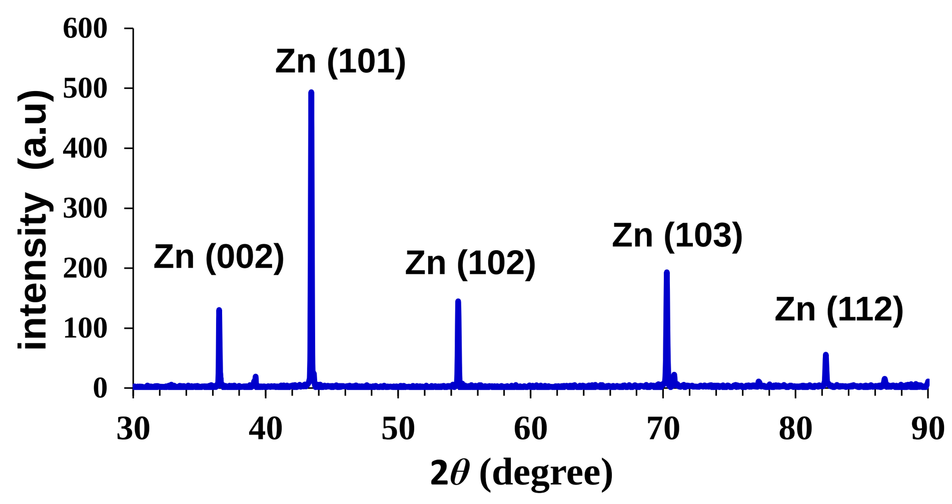
- Galvanostatic experiments were carried out from the working electrolyte S_{Zn-Mn} containing or not **Octylphenylpoly(ethyleneglycol)10 + 3-HBA**
- **Two applied Current densities :**
  1. **j = 30 mA/cm²**
  2. **j = 75 mA/cm²**

Morphological and Structural properties of Zn-Mn alloys

j = 30 mA/cm²

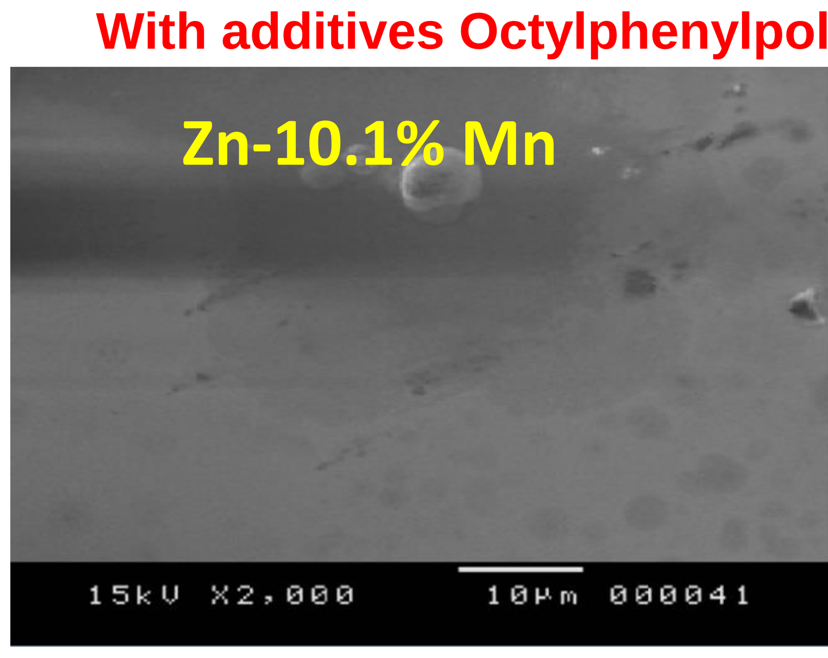
Without additives

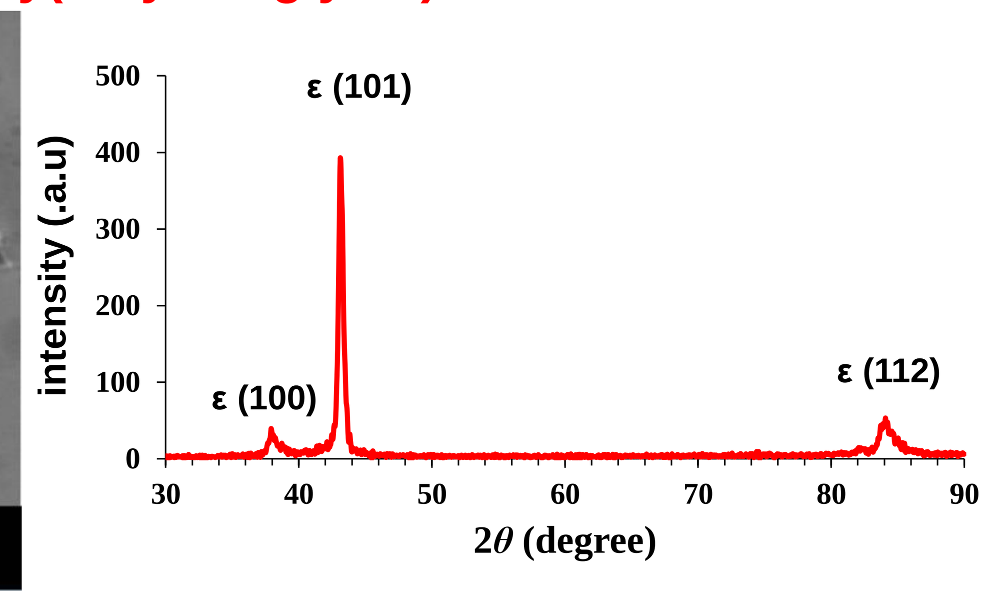




☞ Zn crystals grow under different crystallographic orientations

With additives Octylphenylpoly(ethyleneglycol)10 + 3-HBA





Smooth Zn-Mn alloys

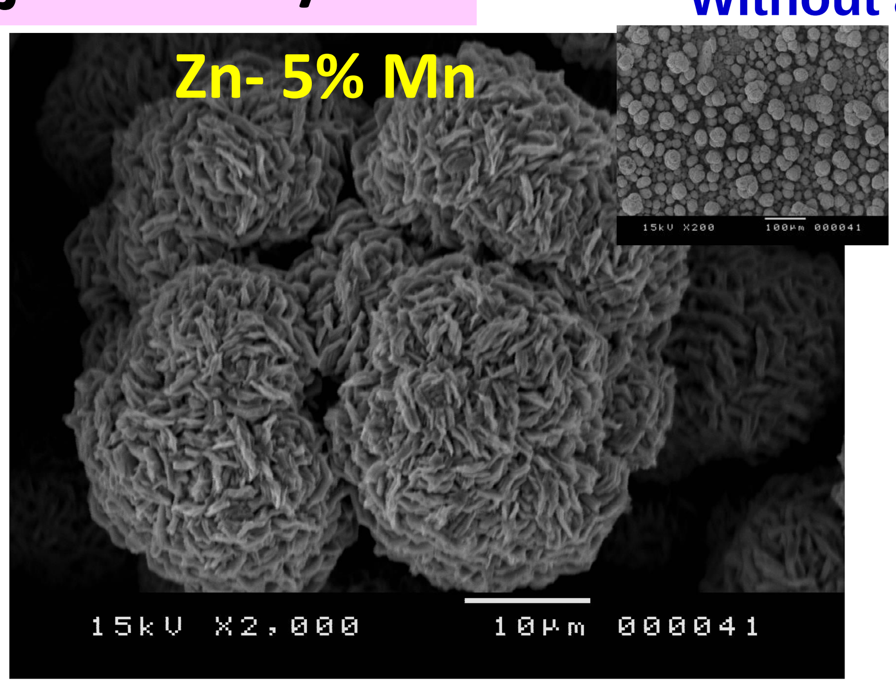
☞ Only ε- Zn-Mn phase

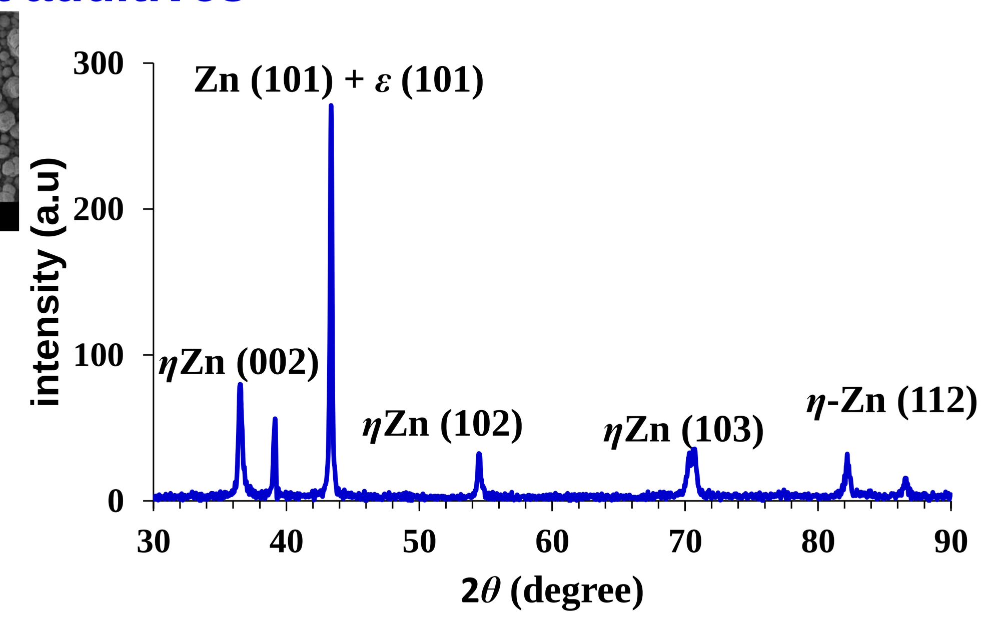
When additives are added into electrolytic bath

- **SEM observation** → : transition from patelet grains of pure Zn to refiner grains
- **XRD patterns** → monophasic alloy preferential orientation along specific direction due to different rates of growth of different faces of the crystal

j = 75 mA/cm²

Without additives

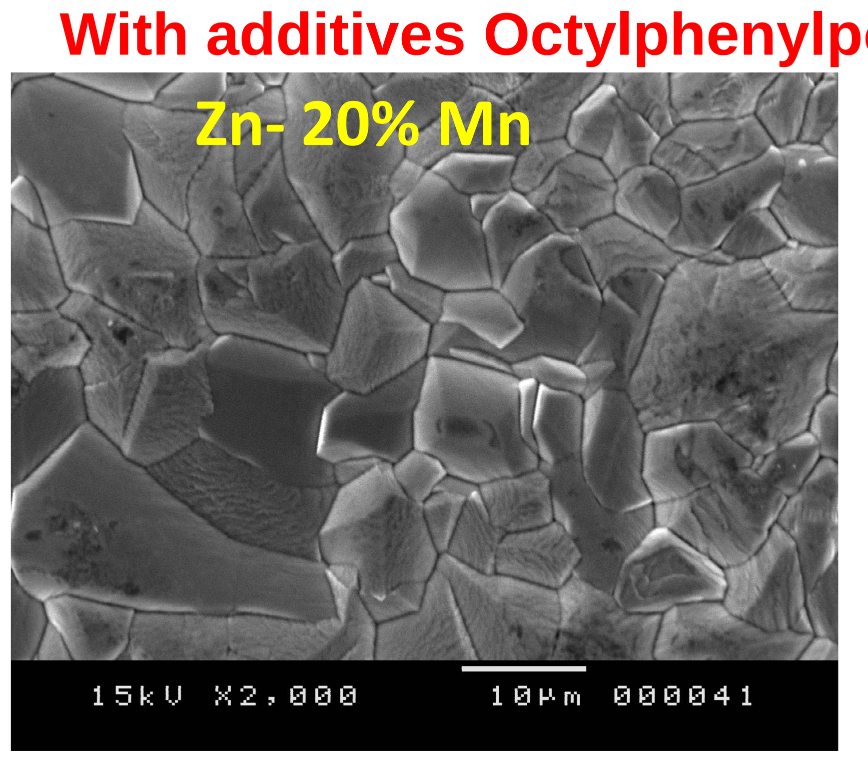


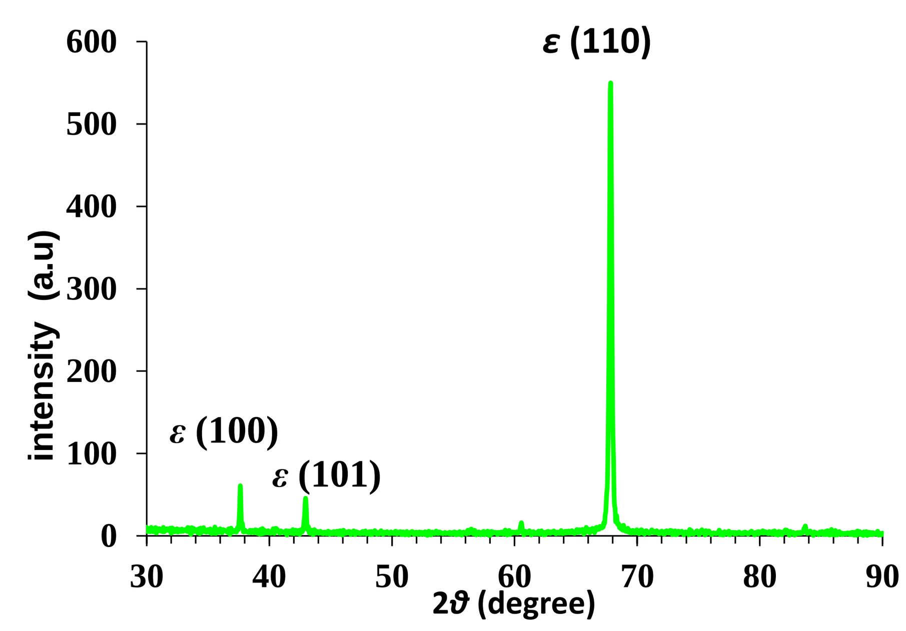


When j increases : → Zn-Mn is dendritic : attesting that the growth process is under diffusion control

☞ Zn-5% Mn is bi-phasic alloy

With additives Octylphenylpoly(ethyleneglycol)10 + 3-HBA





Mn-rich alloys: → Large grains with non-uniform size and shape

☞ At high Mn content → Zn-Mn alloy is monophasic with preferred orientation along **(110)**

Conclusion

Octylphenylpoly(ethyleneglycol)10 and 3-HBA :

- ✓ are turned out to be efficient potential additives to enable an easier Mn incorporation into Zn matrix → Mn-rich alloys are obtained
- ✓ alters Zn-Mn alloy morphology with a preferred orientation.

☞ All modifications in Zn-Mn coatings suggest a change in the nucleation and growth of crystals in presence of additives. This occurrence is associated with the adsorption of organic molecules on the cathode surface.