EIS Characterization of Passive Films Formed on AlxCoCrFeNi Alloys

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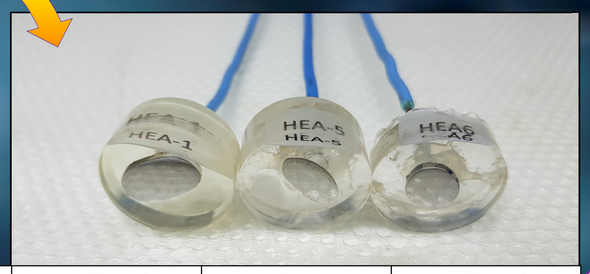
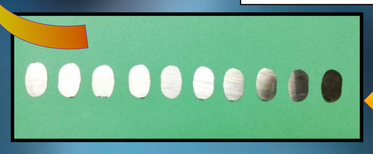
SPECIMENS

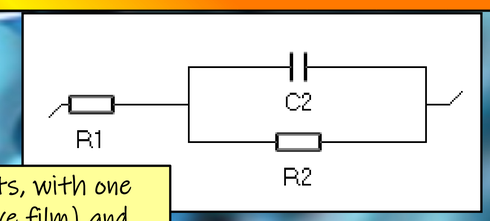


COMPONENTS	HEA 1	HEA 5	HEA 6
	AlCrFeCoNi	$Al_{0.8}CrFeCoNi$	$Al_{0.6}CrFeCoNi$
Al, wt%	10,67	8,72	6,68
Cr, wt%	20,55	21,00	21,47
Fe, wt%	22,13	22,61	23,12
Co, wt%	23,32	23,82	24,36
Ni, wt%	23,33	23,85	24,36

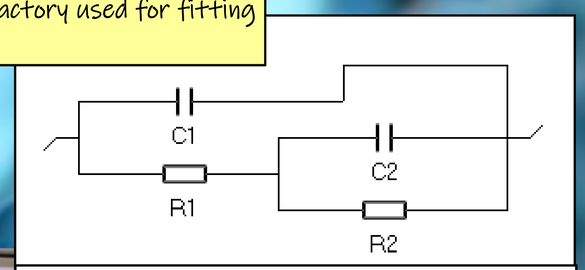


Electrochemical Impedance Spectroscopy (EIS) measurements have been performed on High Entropy Alloys (HEAs) type AlxCoCrFeNi with different aluminium content (x = 0.6; 0.8 and 1.0) in order to characterize their passive film and corrosion resistance at 37ºC under simulated physiological conditions (Ringer´s solution) acidulated with HCl at pH=3

CORROSION BEHAVIOUR



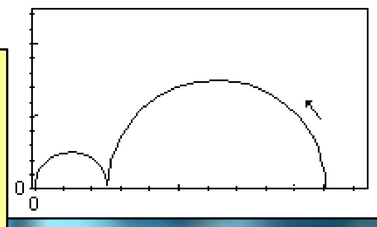
Two equivalent circuits, with one time constant (passive film) and two time constants (charge transfer reactions) respectively, can be satisfactory used for fitting the spectra.



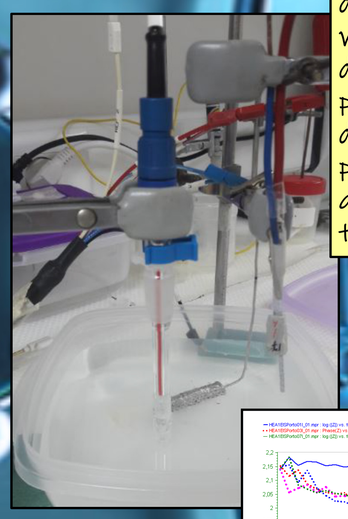
Impedance

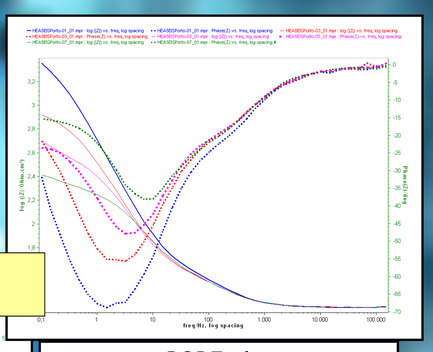
$$Z(f) = \frac{R_2 + R_1(1 + j2\pi f C_2 R_2)}{1 + j2\pi f C_2 R_2 + j2\pi f C_1 (R_2 + R_1(1 + j2\pi f C_2 R_2))}$$

Nyquist Diagram (-Im(Z) vs. Re(Z))



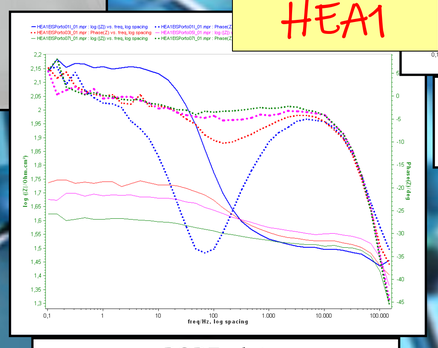
The polarization resistance and the double layer capacity were compared at different polarization potentials for the detection of the passive film structure and the roughness of the electrode surface .



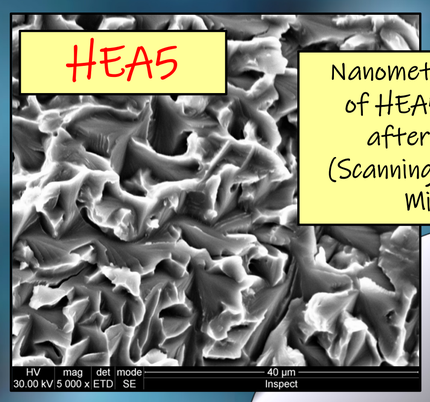


BODE plot
log(Z) vs frequency vs phase (Z)
[-0.7V - E_{corr}]

HEA1



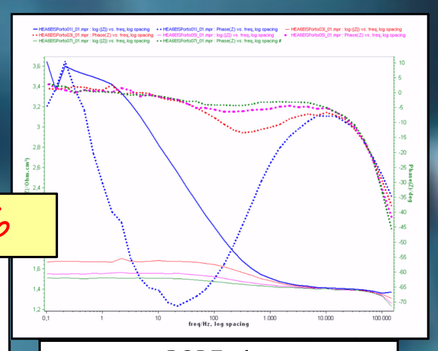
BODE plot
log(Z) vs frequency vs phase (Z)
[E_{corr} - 0.7V]



HEA5

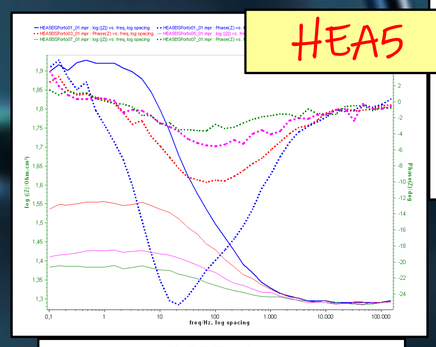
Nanometric image of HEA5 surface after fracture (Scanning Electron Microscope)

METALLOGRAPHY

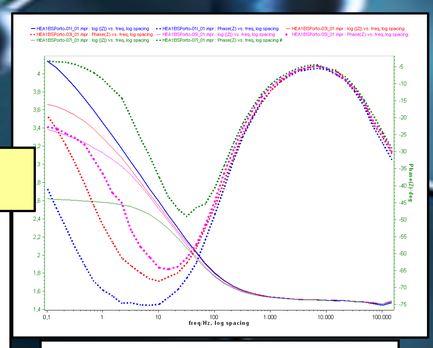


BODE plot
log(Z) vs frequency vs phase (Z)
[-0.7V - E_{corr}]

HEA5

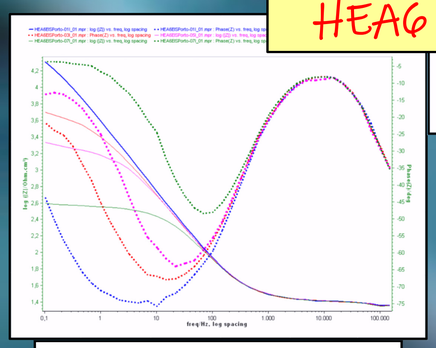


BODE plot
log(Z) vs frequency vs phase (Z)
[E_{corr} - 0.7V]



BODE plot
log(Z) vs frequency vs phase (Z)
[-0.7V - E_{corr}]

HEA6



BODE plot
log(Z) vs frequency vs phase (Z)
[E_{corr} - 0.7V]

There is a decrease in the values of the impedance of CPE (slope of the lg[Z] vs lg(f) in Bode plots), related to the rugosity of the electrode surface.

It can be seen for all materials that the resistance of the passive film is very high and decreases slightly with the potential : the very high resistance of the passive film implies a high corrosion resistance which can be attributed to the formation of the protective oxide layer.

ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY

R. Kotoka et al. / Journal of Materials Science & Technology 31 (2015) 873–880