Swansea University
Prifysgol Abertawe

MATERIALS AND MANUFACTURING ACADEMY

TATA STEEL

Aesthetic and performance enhancements of ZMA coated steels

By: Amar .D. Malla
Academic Supervisor: Prof. James Sullivan
Industrial Supervisor: Dr. Bekir Salgin, Dr. Peter Barker

EPSRC
Engineering and Physical Sciences Research Council

Research Fund for Coal & Steel

MicroCorr

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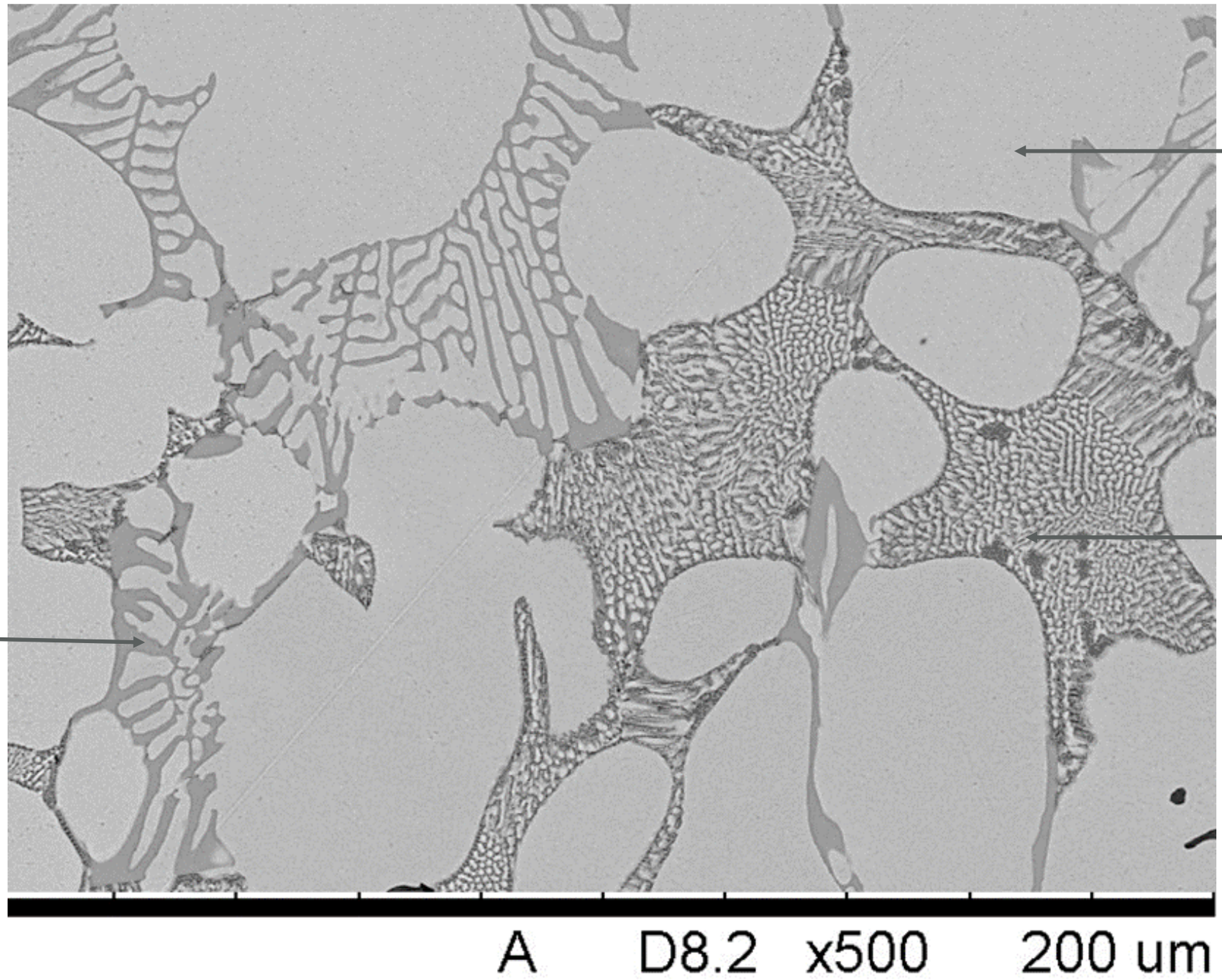
Zinc Magnesium Aluminium (ZMA):

- Provides cathodic protection
- Acts as barrier

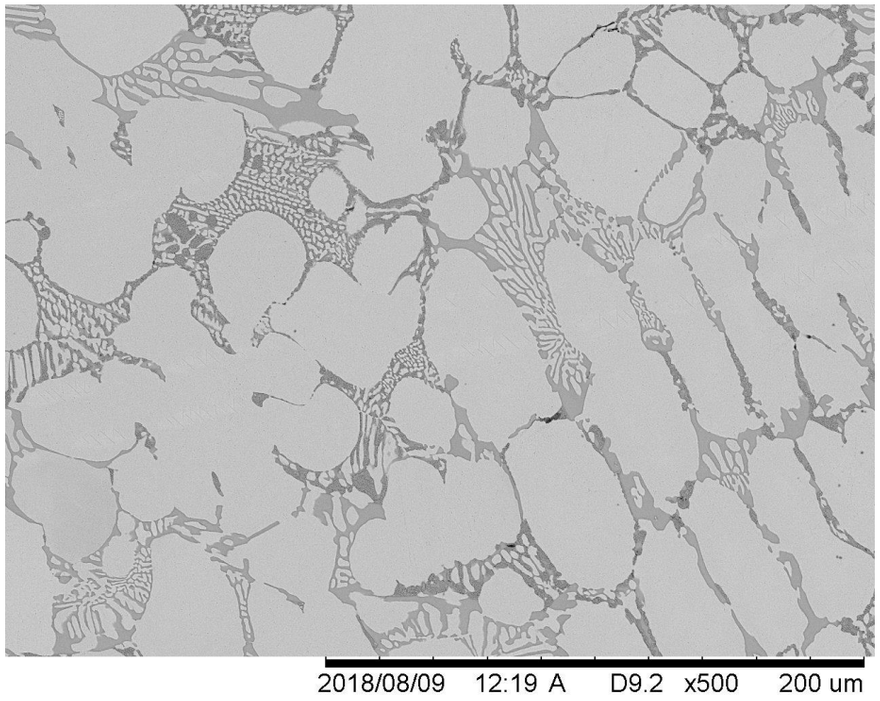
Microstructure of ZMA:



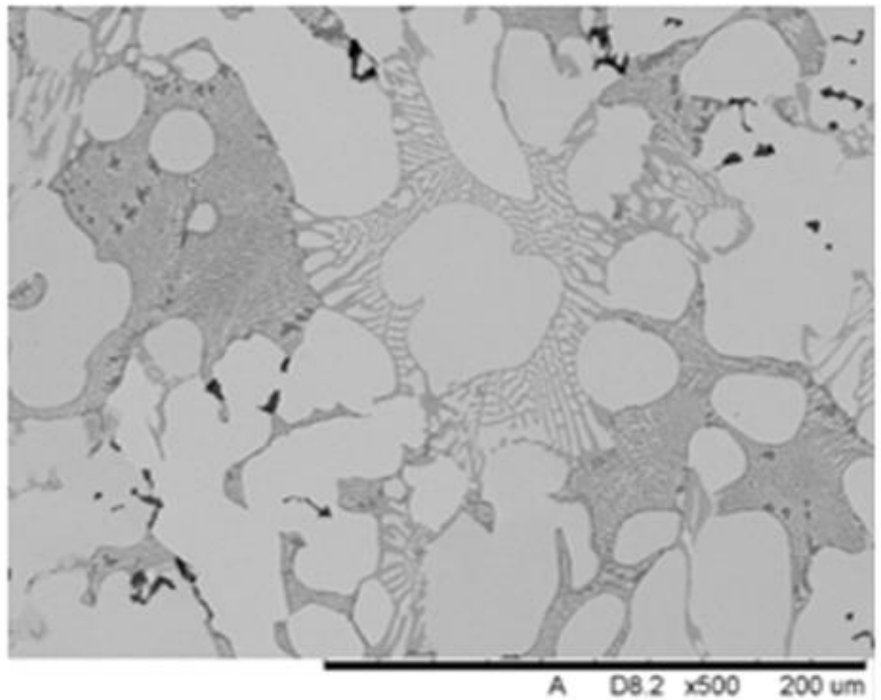
Zn – (1-2) wt.% Al – (1-2) wt.% Mg

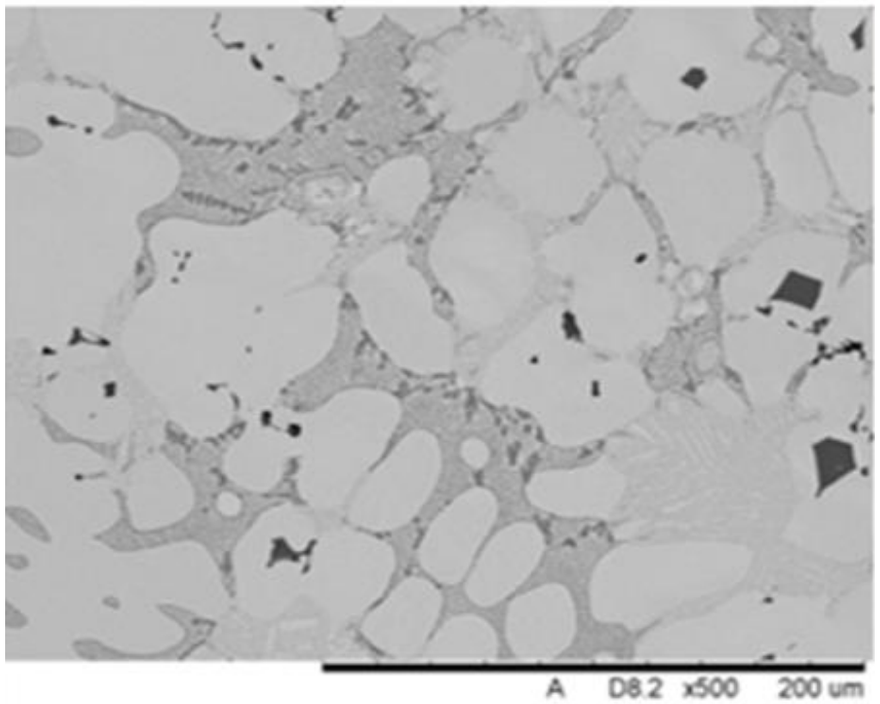
Experimental samples:

0 Ge

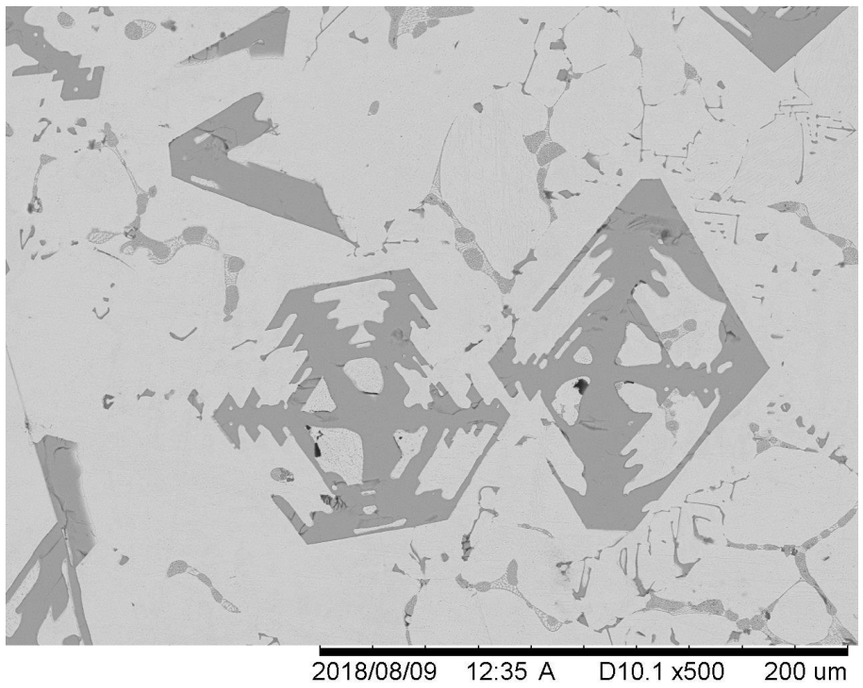


0.19 Ge



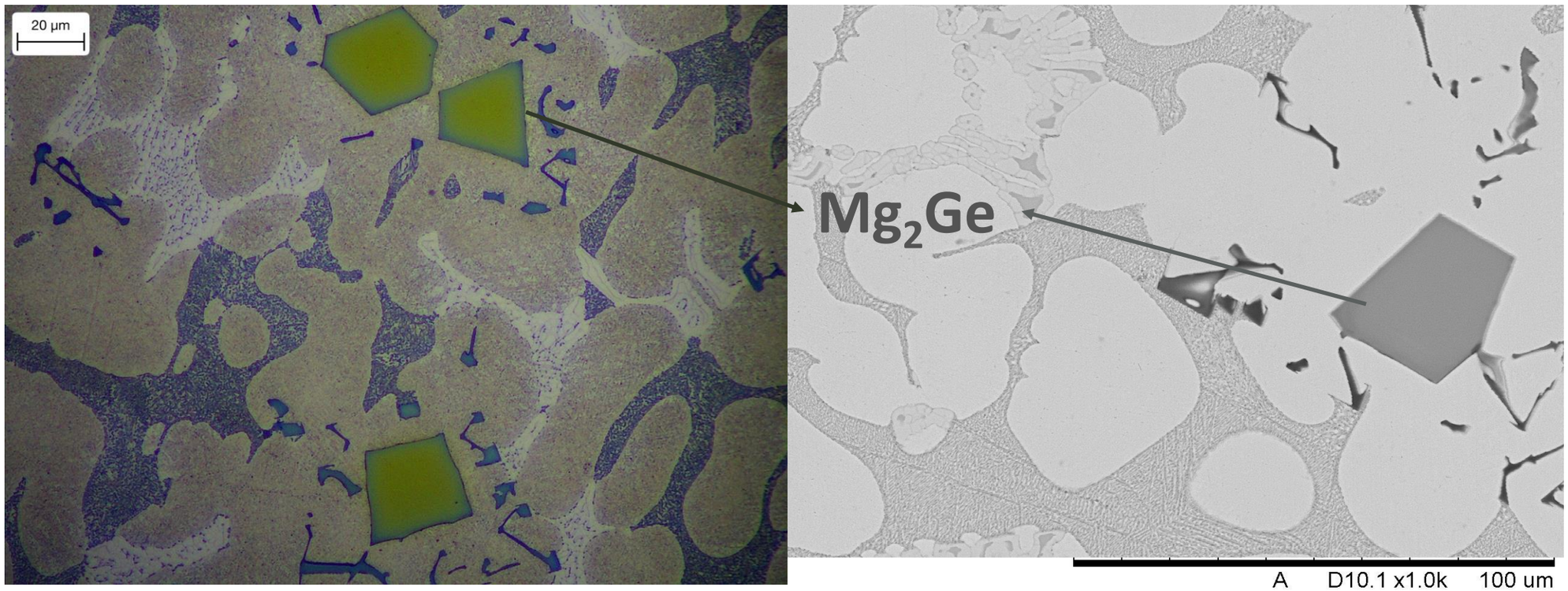


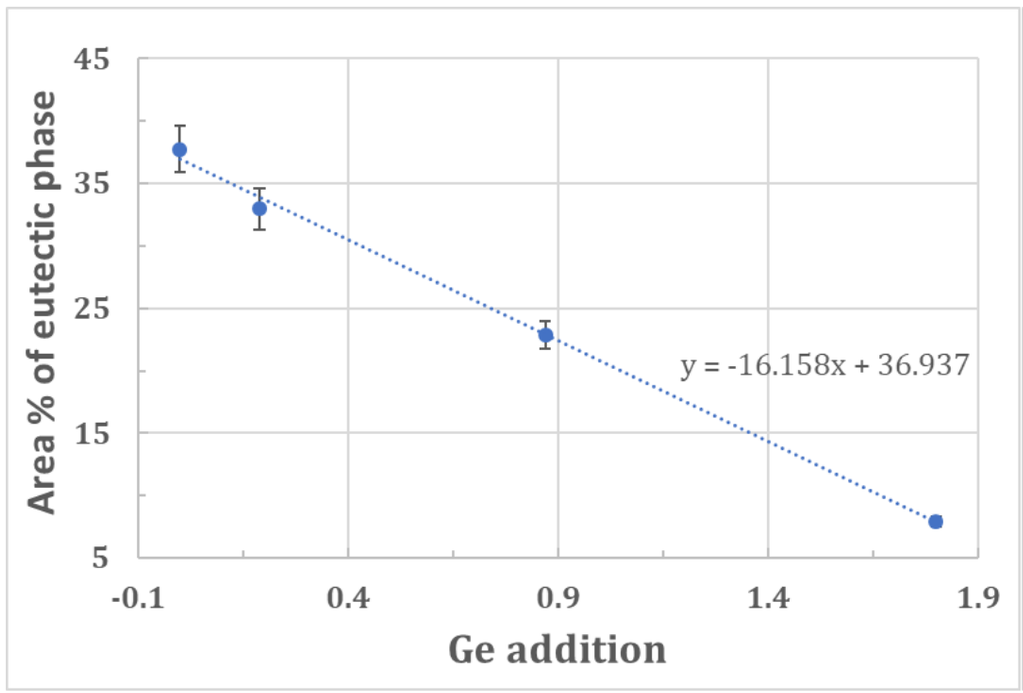
0.87 Ge

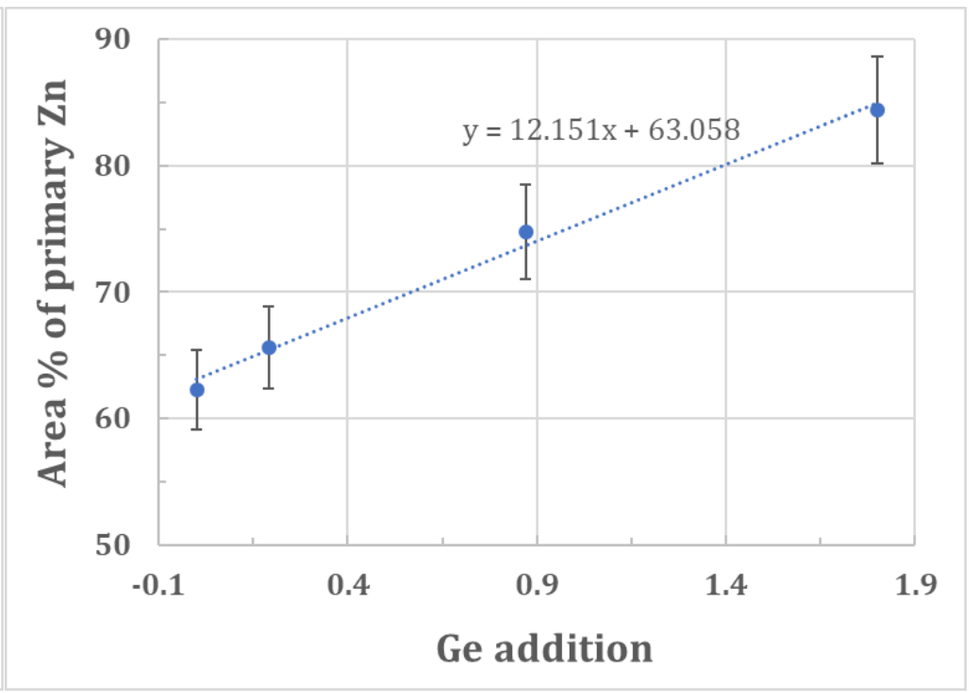


1.8 Ge

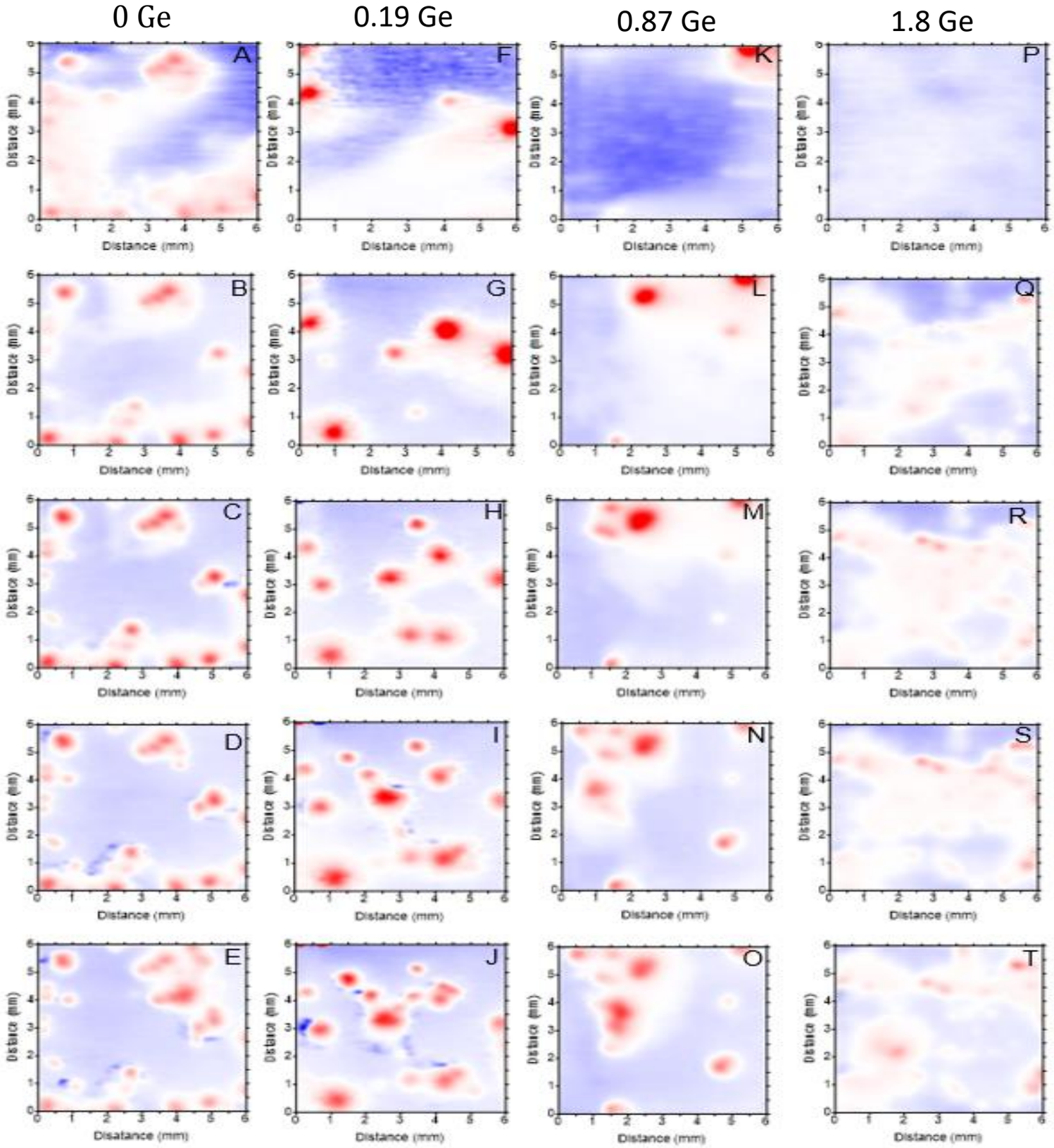
Volume fraction analysis:







SVET : Results

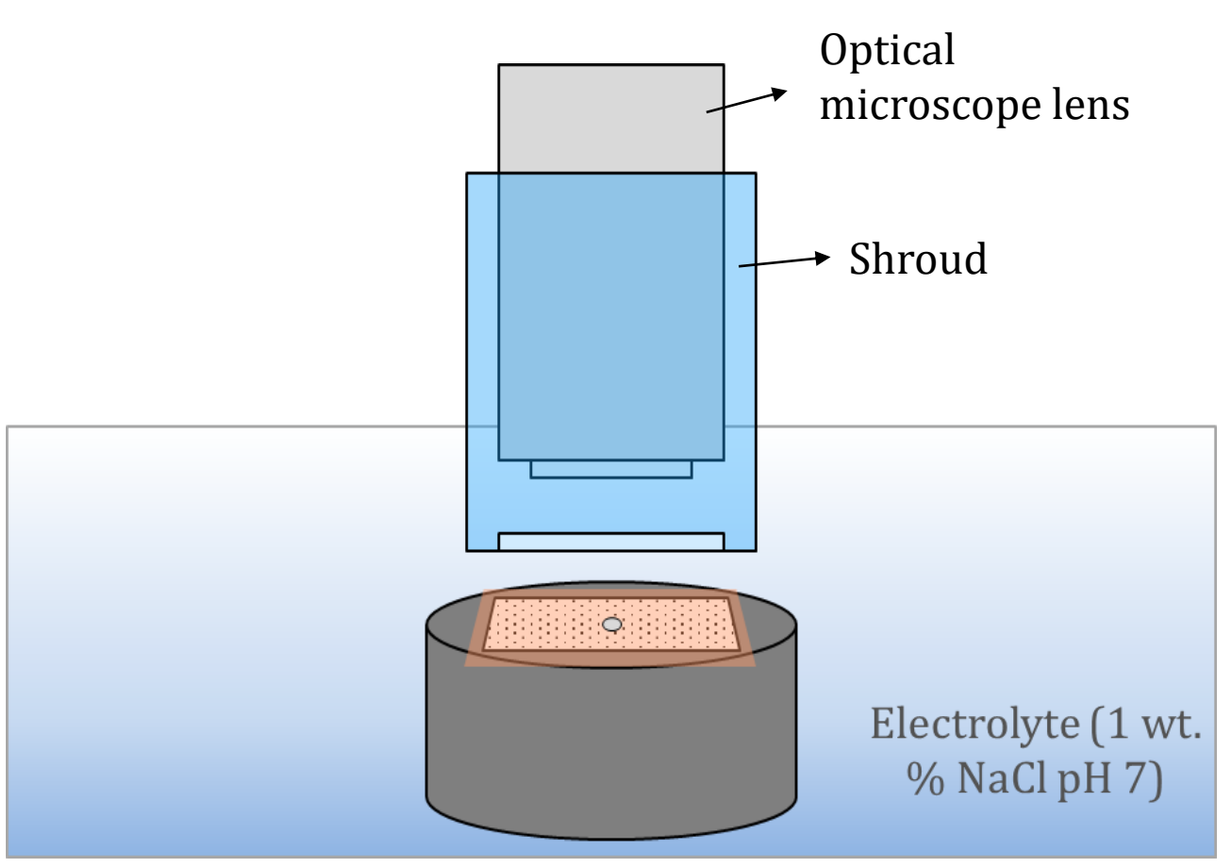


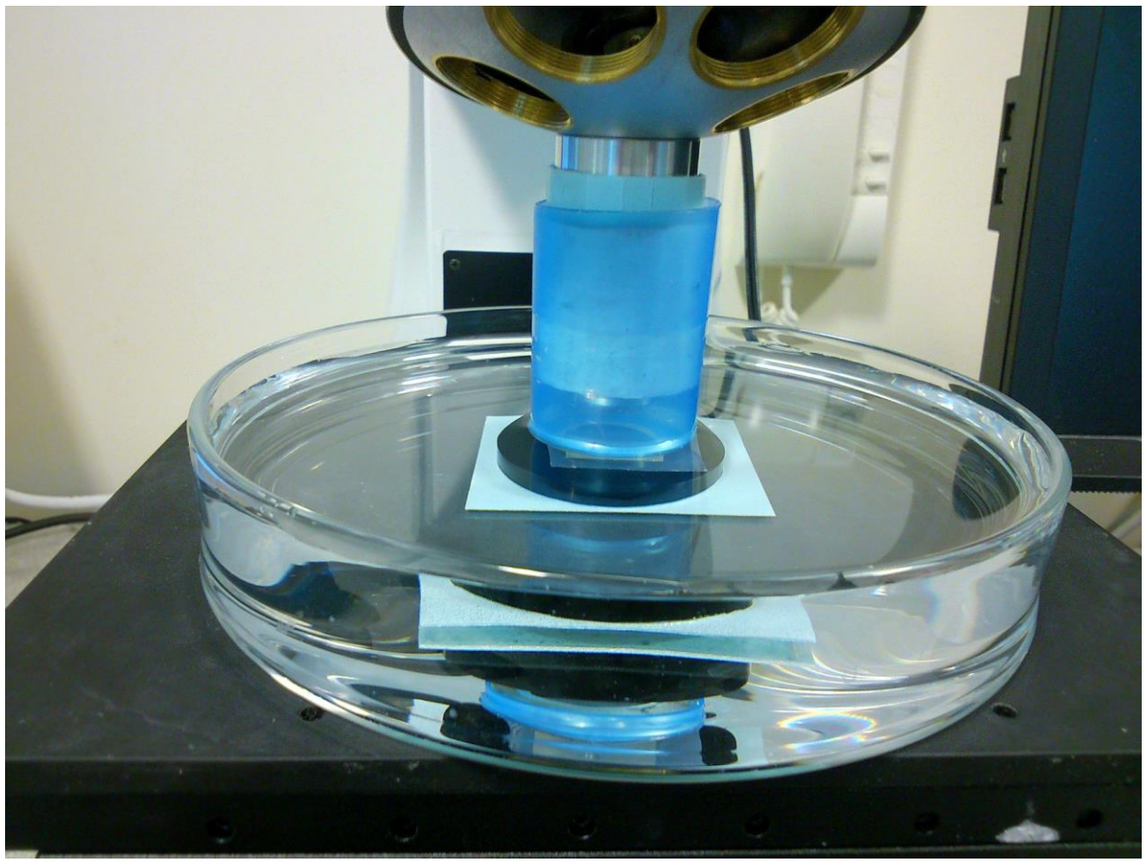
Sample	Mass Loss (g/m^2)
0 Ge	5.01 ± 0.49
0.19 Ge	8.53 ± 2.16
0.87 Ge	4.41 ± 0.51
1.80 Ge	2.11 ± 0.84

Electrolyte: 1 wt.%. NaCl
pH 7

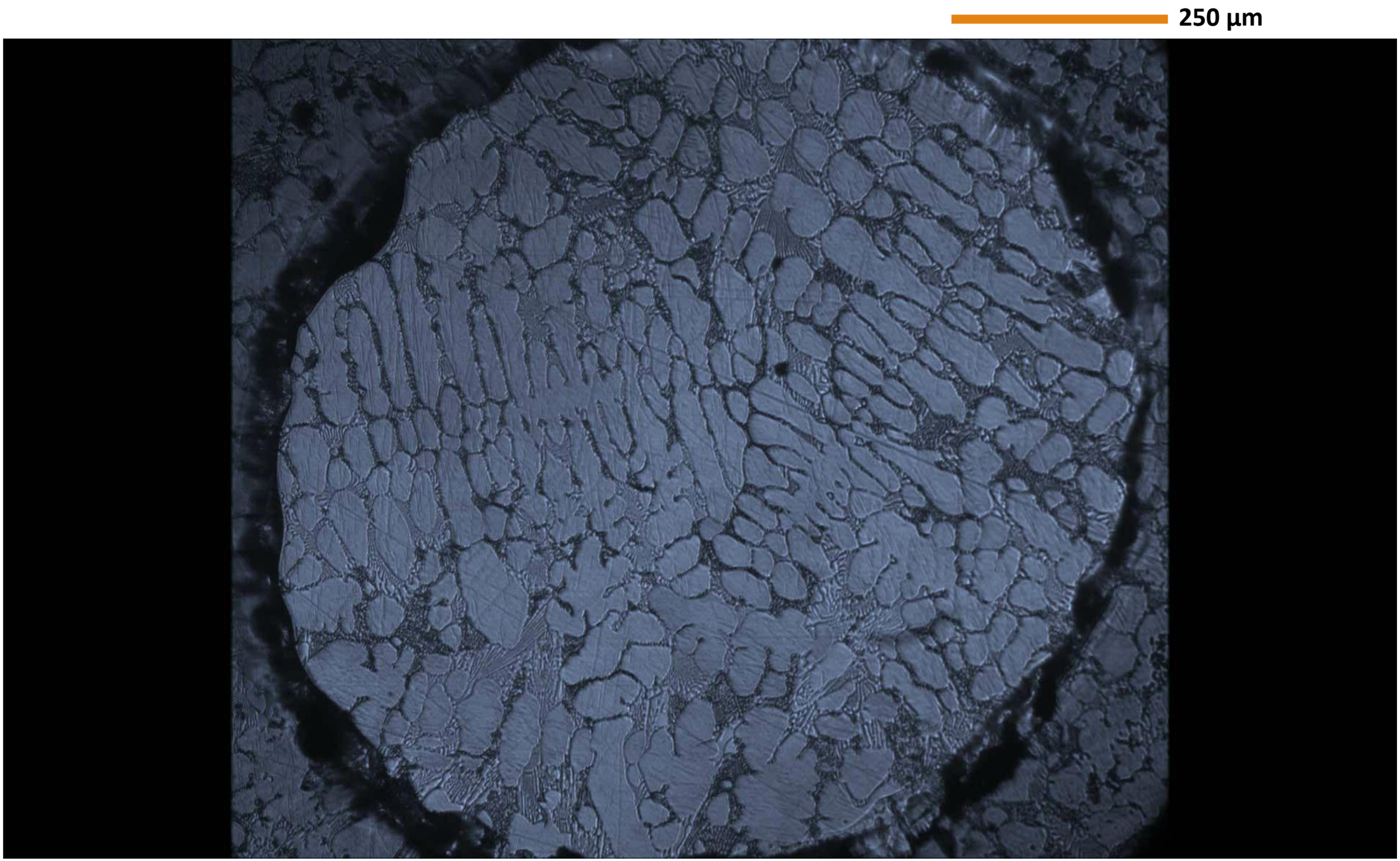
Time: 24 hours

Time-lapse Microscopy (TLM):

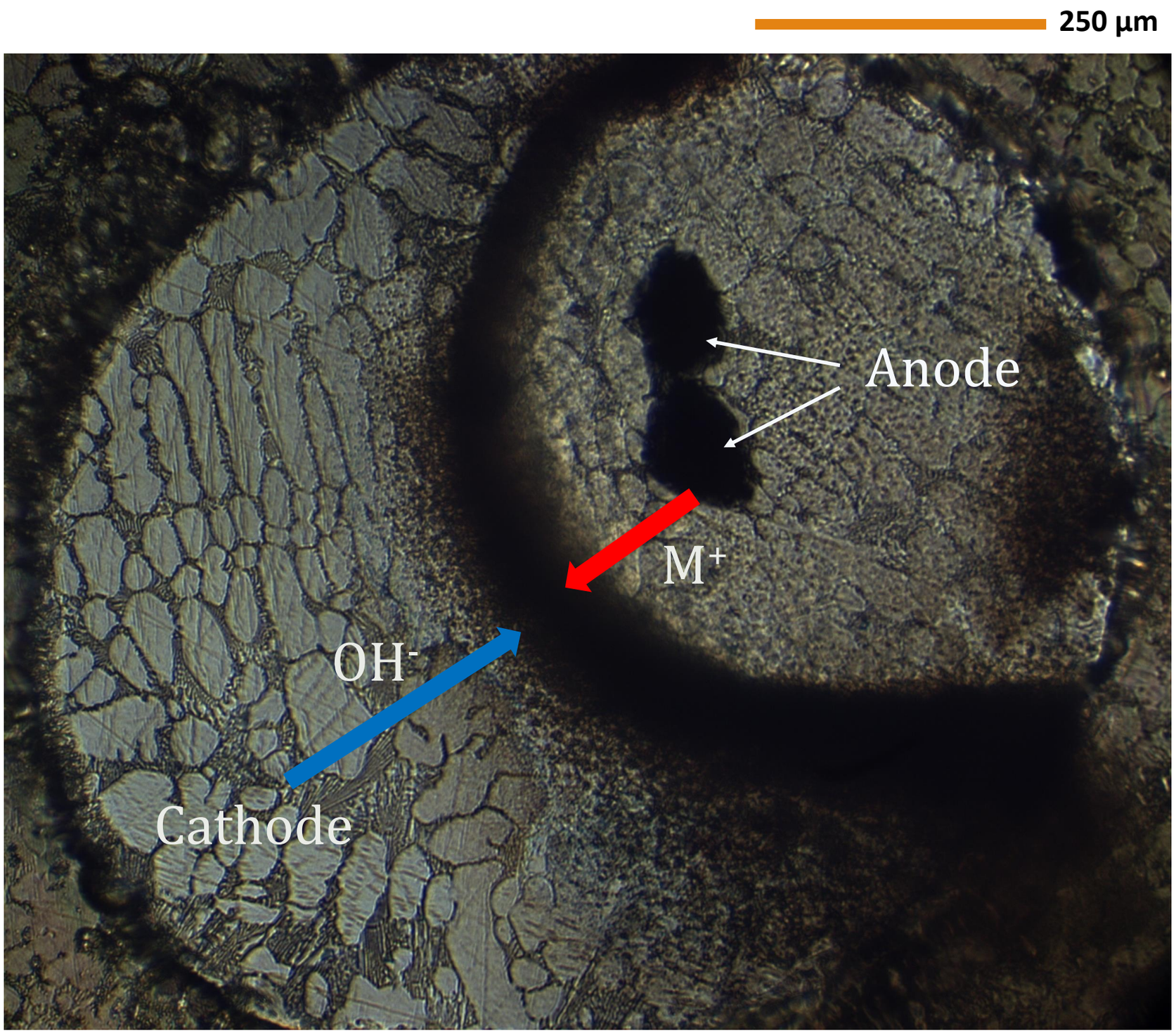




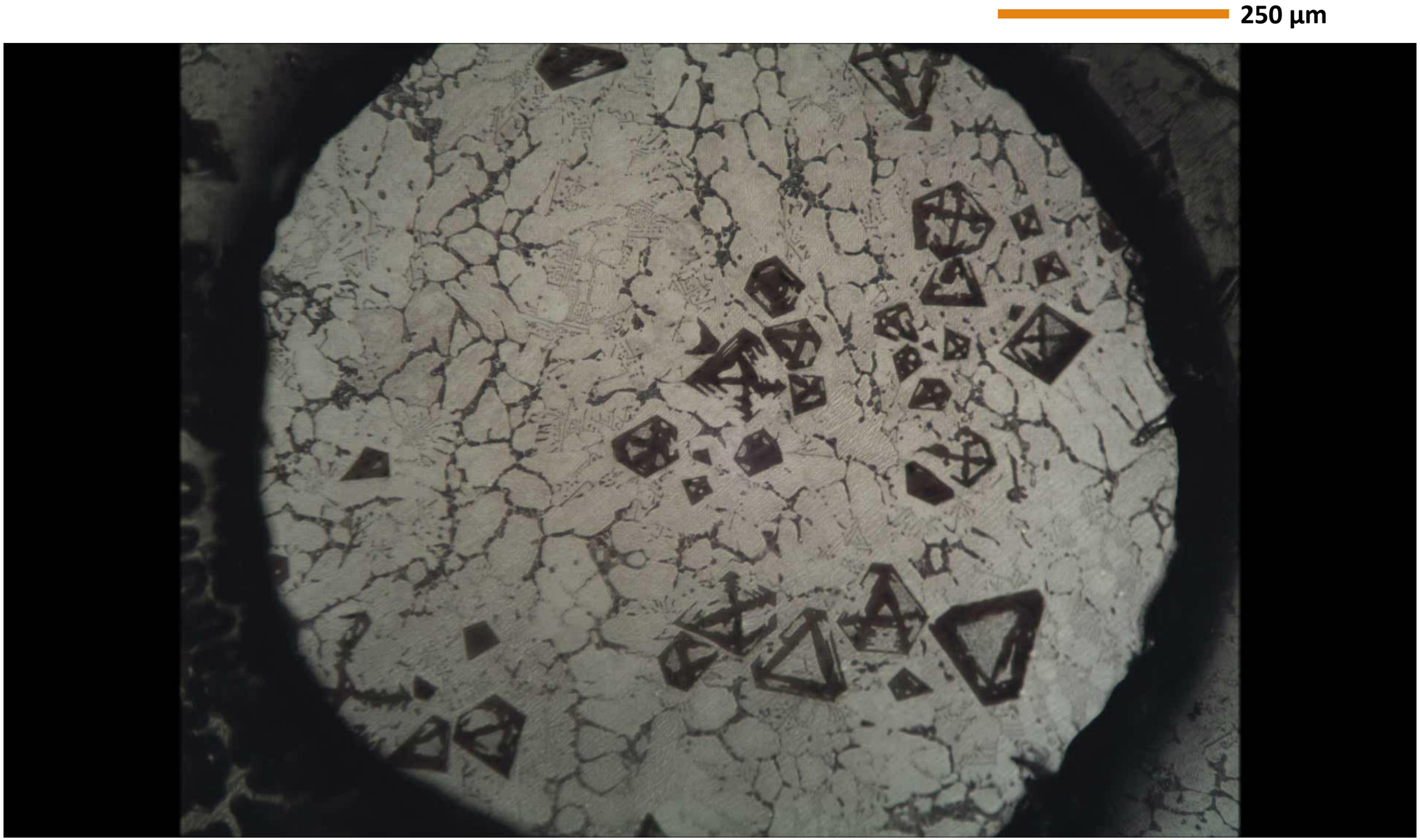
TLM: 0 Ge in 1 wt.% NaCl pH 7 for 24 hours



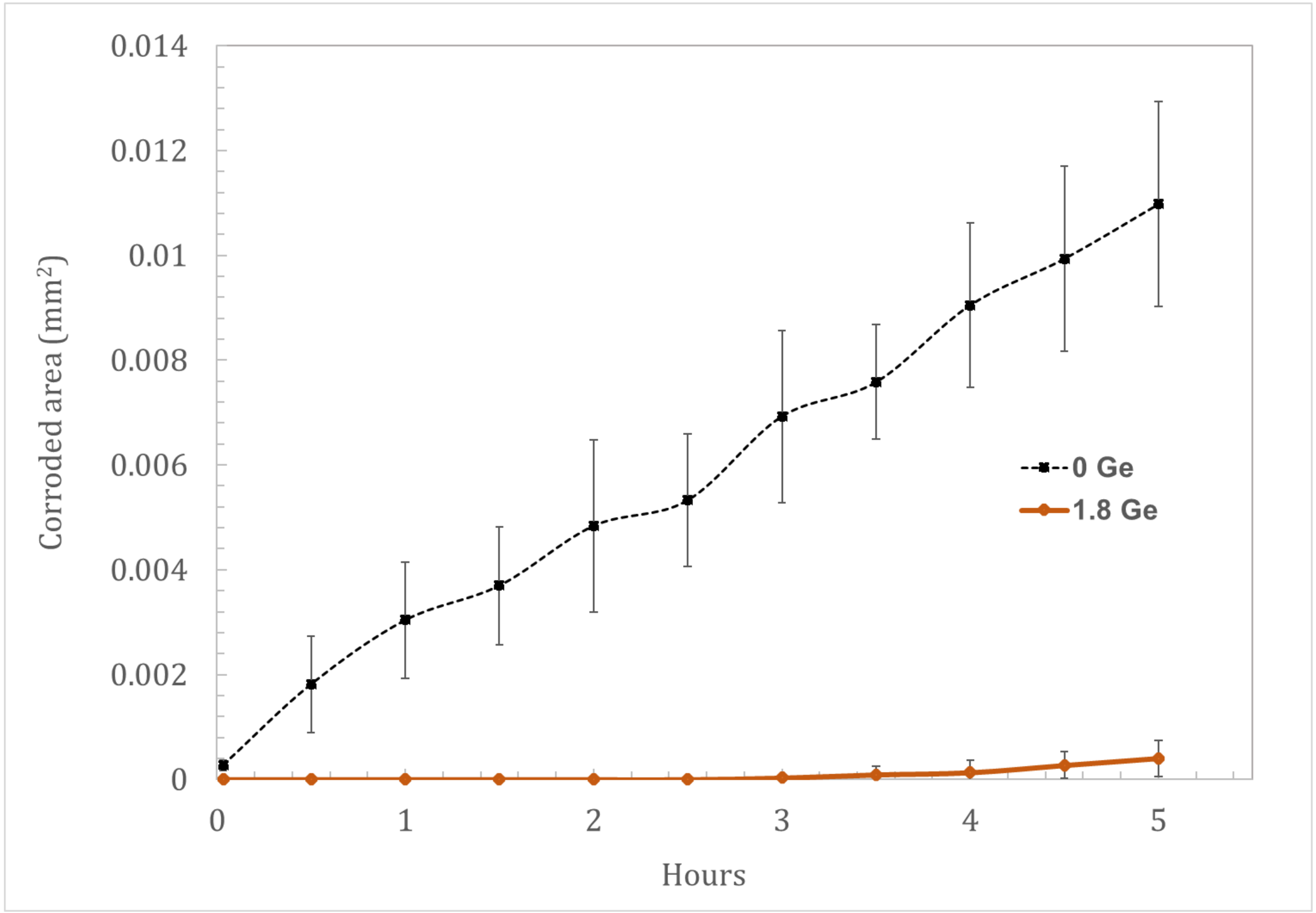
TLM: ZMA- 0 Ge



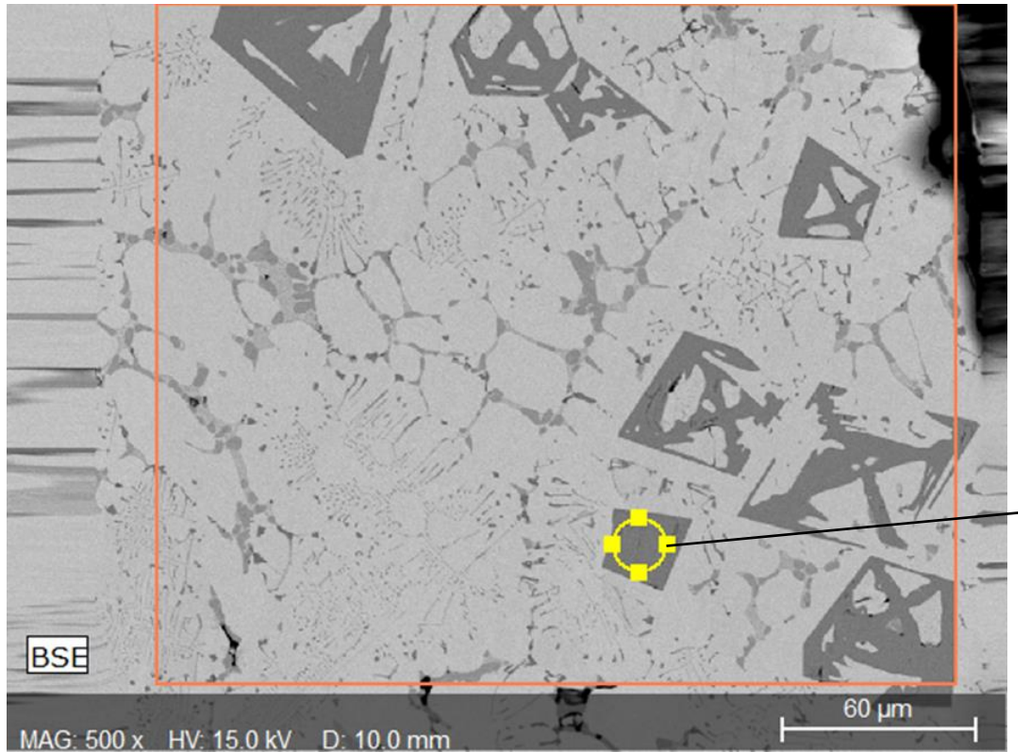
TLM: ZMA – 1.8 Ge in 1 Wt. % NaCl pH 7 for 24 hours



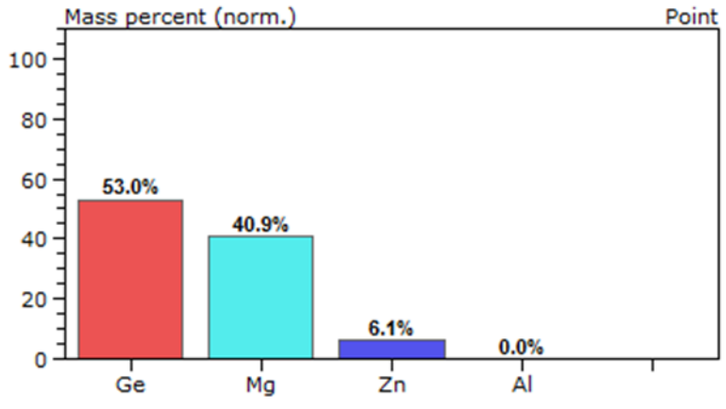
Corroded Area:

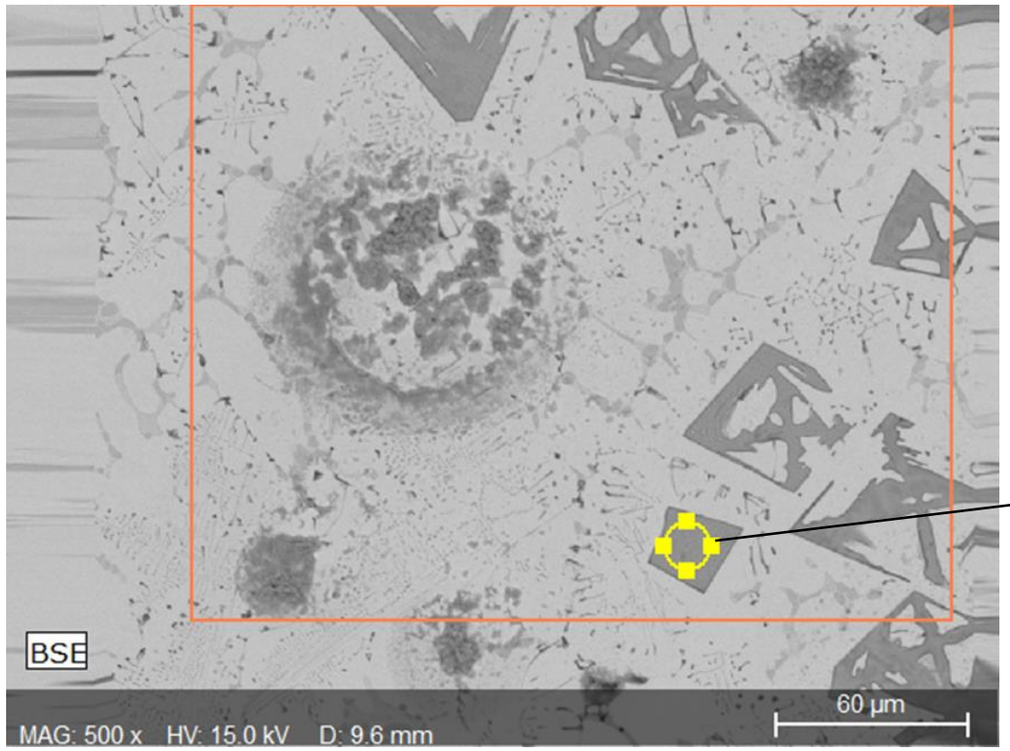


Scanning Electron Microscope (SEM): EDS analysis of Mg_2Ge crystal before & after 2 hours of immersion

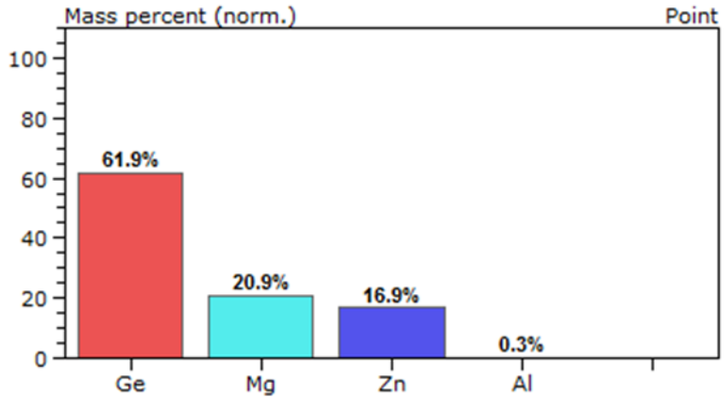


Element	Norm. C (wt. %)
Germanium	52.98
Magnesium	40.92
Zinc	6.09
Aluminium	0.00
Total	100.00

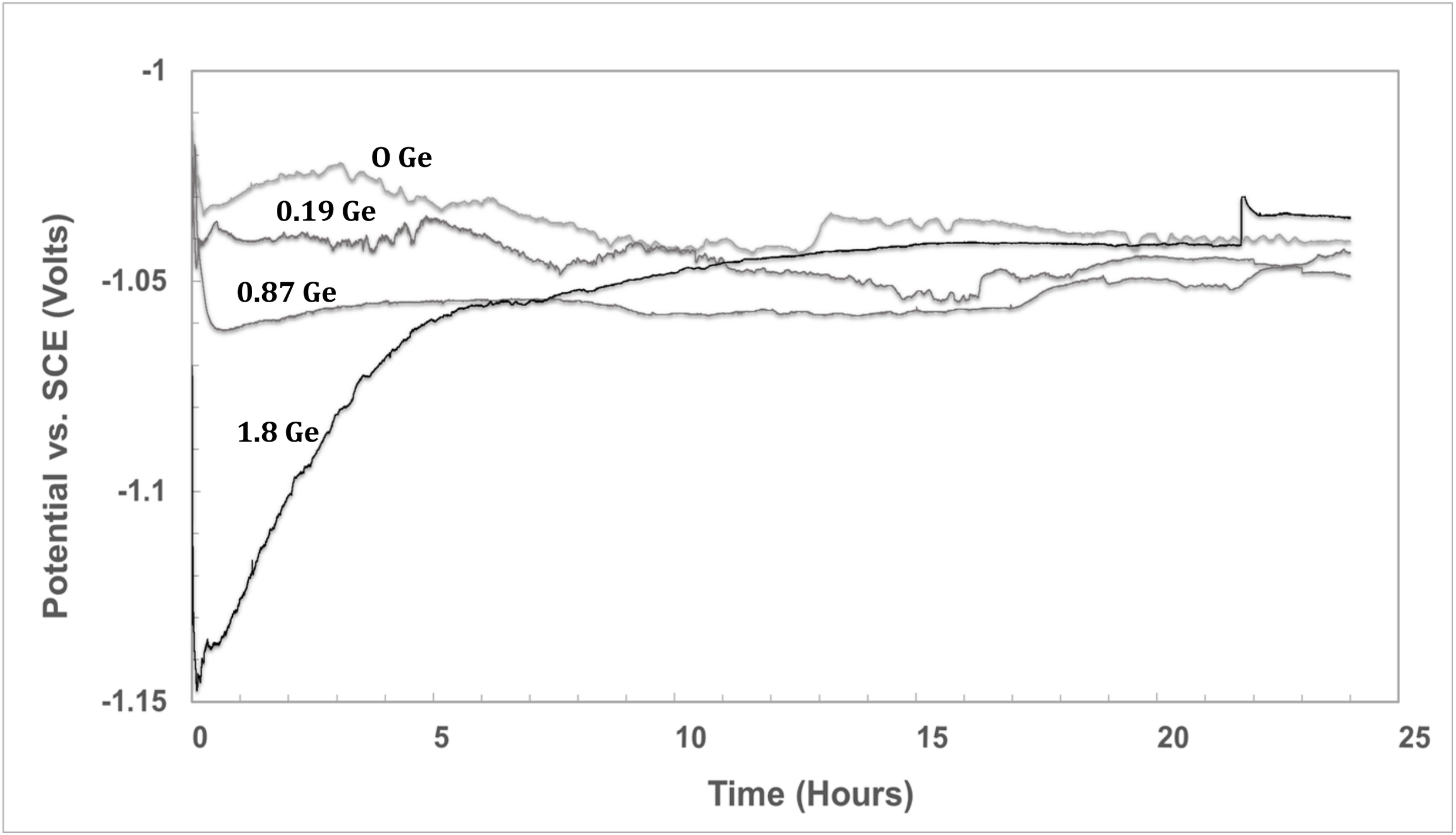




Element	Norm. C (wt. %)
Germanium	61.90
Magnesium	20.91
Zinc	16.88
Aluminium	0.31
Total	100.00

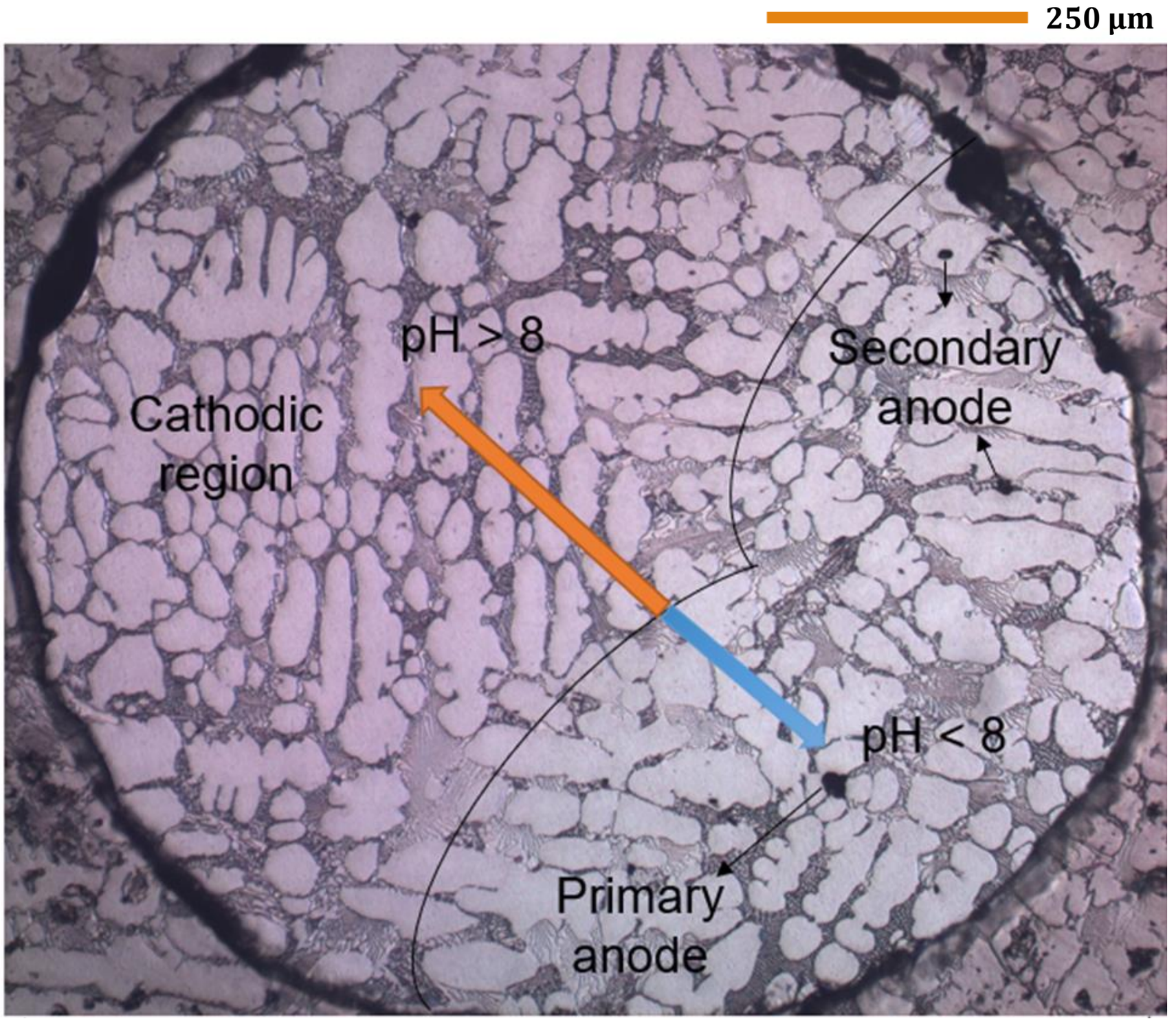


Electrochemical Measurements: OCP

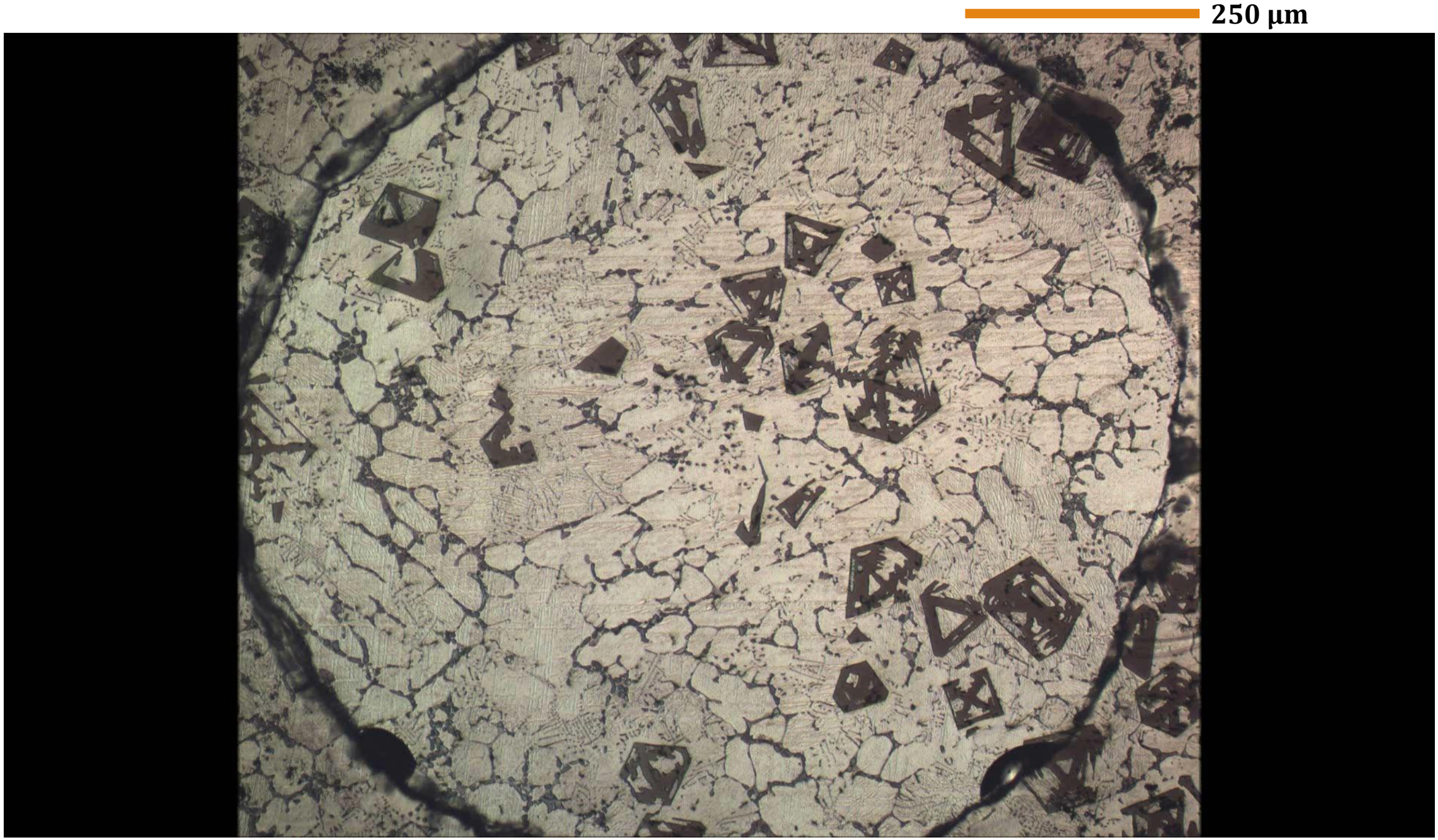


TLM: 0 Ge Indicator in 1 wt. % NaCl pH 7 with indicator for 24 hours

TLM: 0 Ge (Indicator) after 4 minutes

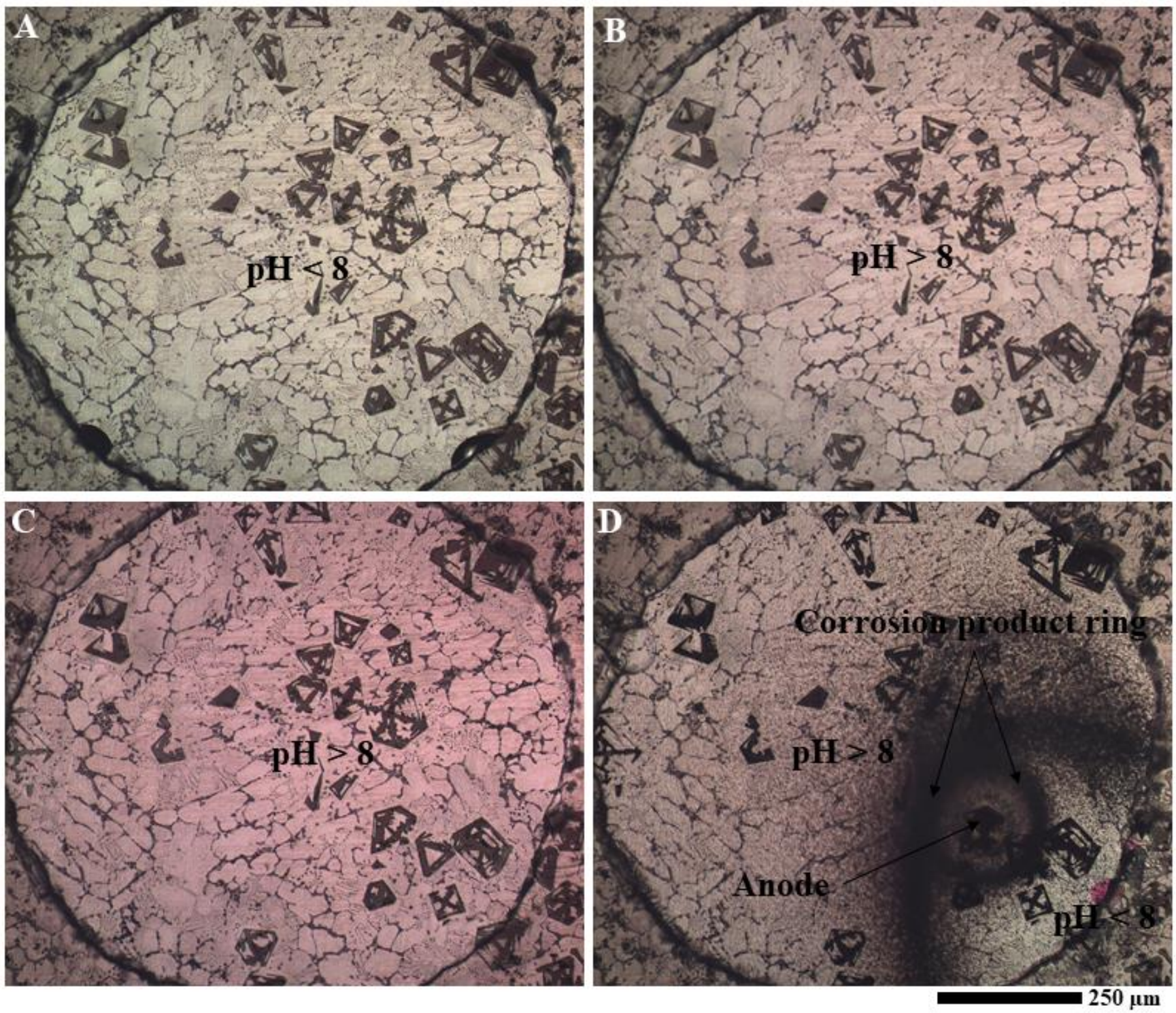


TLM: 1.8 Ge Indicator in 1 wt. % NaCl pH 7 with indicator for 24 hours



TML: 1.8 Ge (Indicator)

2 minute

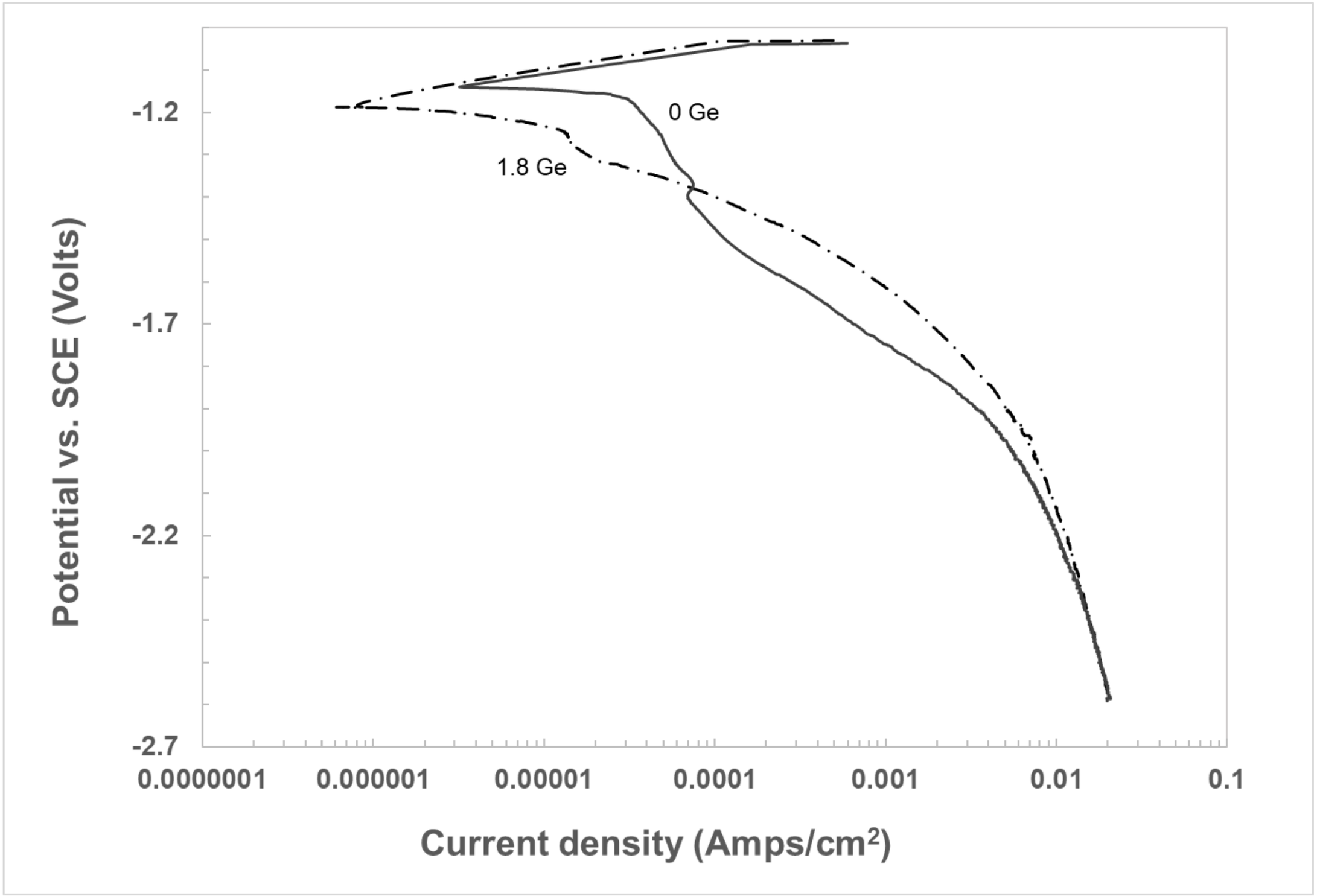


4 minute

1 hour

14 hours

Electrochemical Measurements: Cathodic polarisation



Conclusion:

- Leads to formation of Mg_2Ge crystals
- Mg_2Ge act as Mg^+ reservoir
- Mg^+ ions leads to increase in pH, consequently improving corrosion resistance.

Thank You

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