Temperature influence on PANI growth as a protective coating for PEMFC bipolar plates

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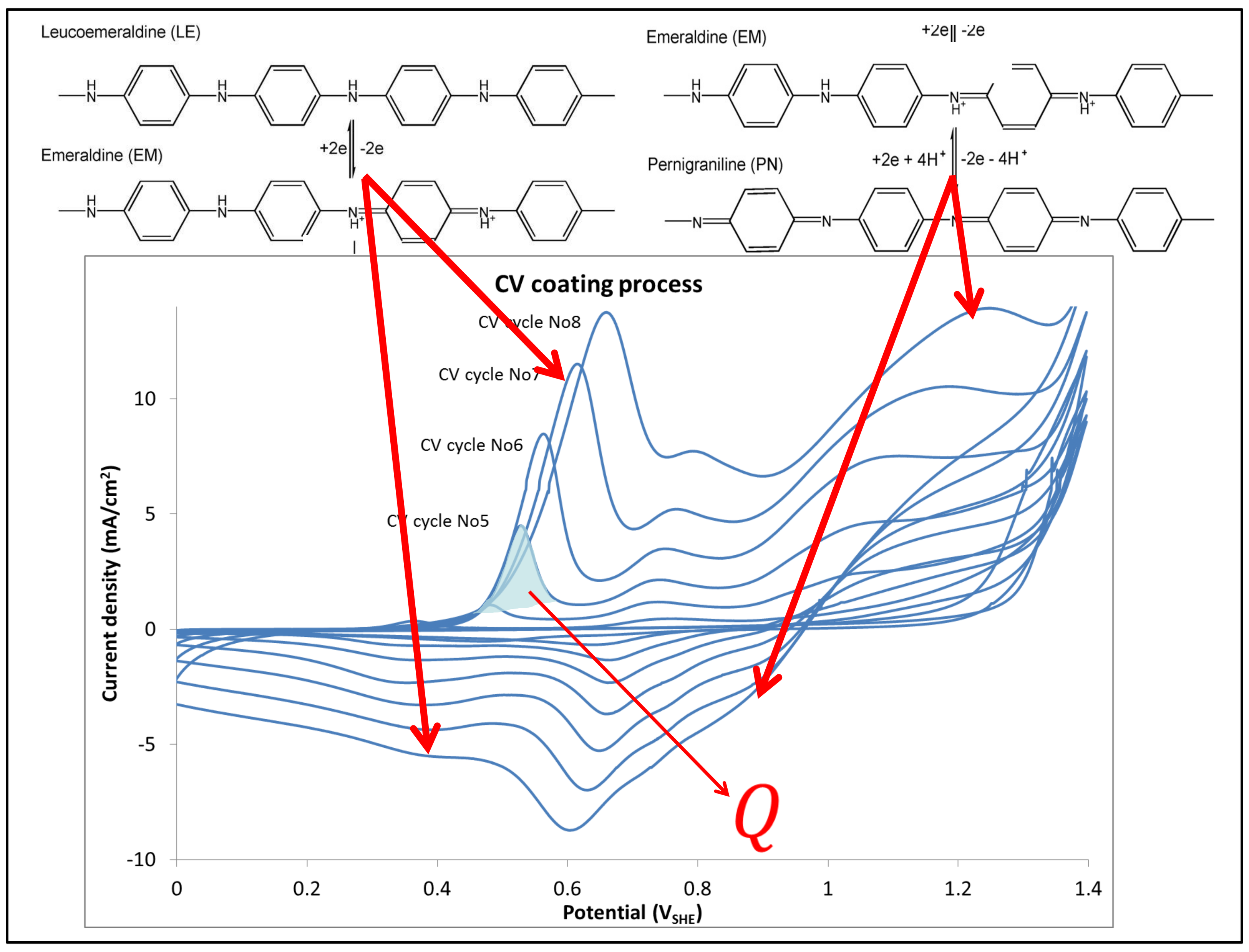
Introduction

One of the most promising ways to cut down the price size and weight of present PEMFC stacks is to use stamped metallic bipolar plates (BPP) instead of graphite BPP. However, the acidic environment of the fuel cell tends to induce corrosion on metallic bipolar plates and for this reason they require protective coatings. In terms of durability and long term fuel cell performance, stainless steel coated with gold is the combination that is presented as the state of the art. However, this is not economically viable and hence the need to explore other cheaper and effective coatings including intrinsically conductive polymers like polyanilne (PANI). This work explores the effect of growth temperature on PANI coating thickness and morphology and consequently its effect on corrosion resistance.

Coating process

3 electrode electrochemical coating setup

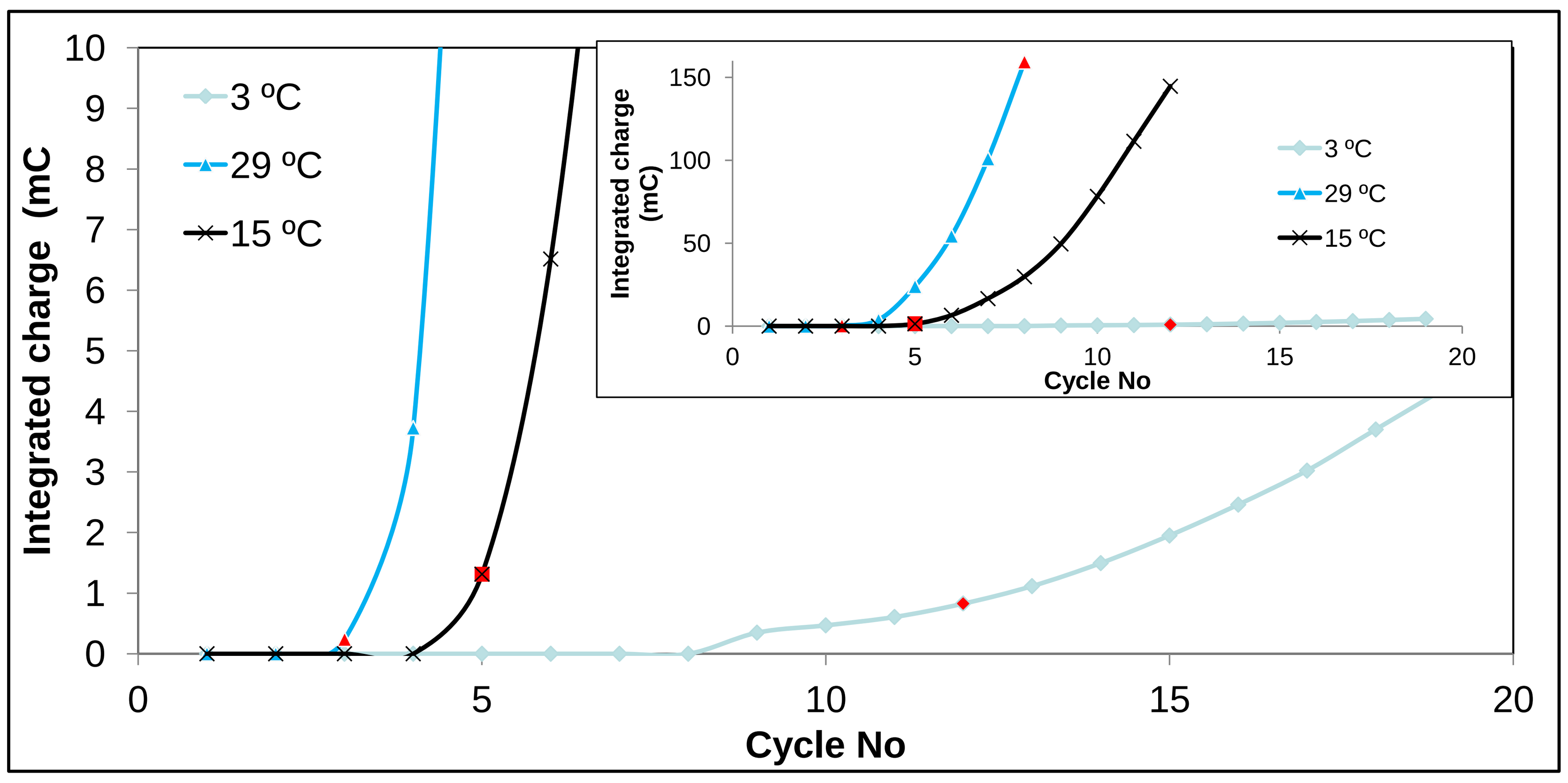
- Substrate: Stainless steel 316L partially masked
- Coated area: 6.3 cm^2
- Jacketed cell: constant temperature
- Reference electrode: Ag/AgCl (KCl saturated)
- Counter electrode: Pt wire
- Electrolyte: 0.5M H_2SO_4 + 0.1M aniline
- Coating mode: cyclic voltammetry 50mV/s



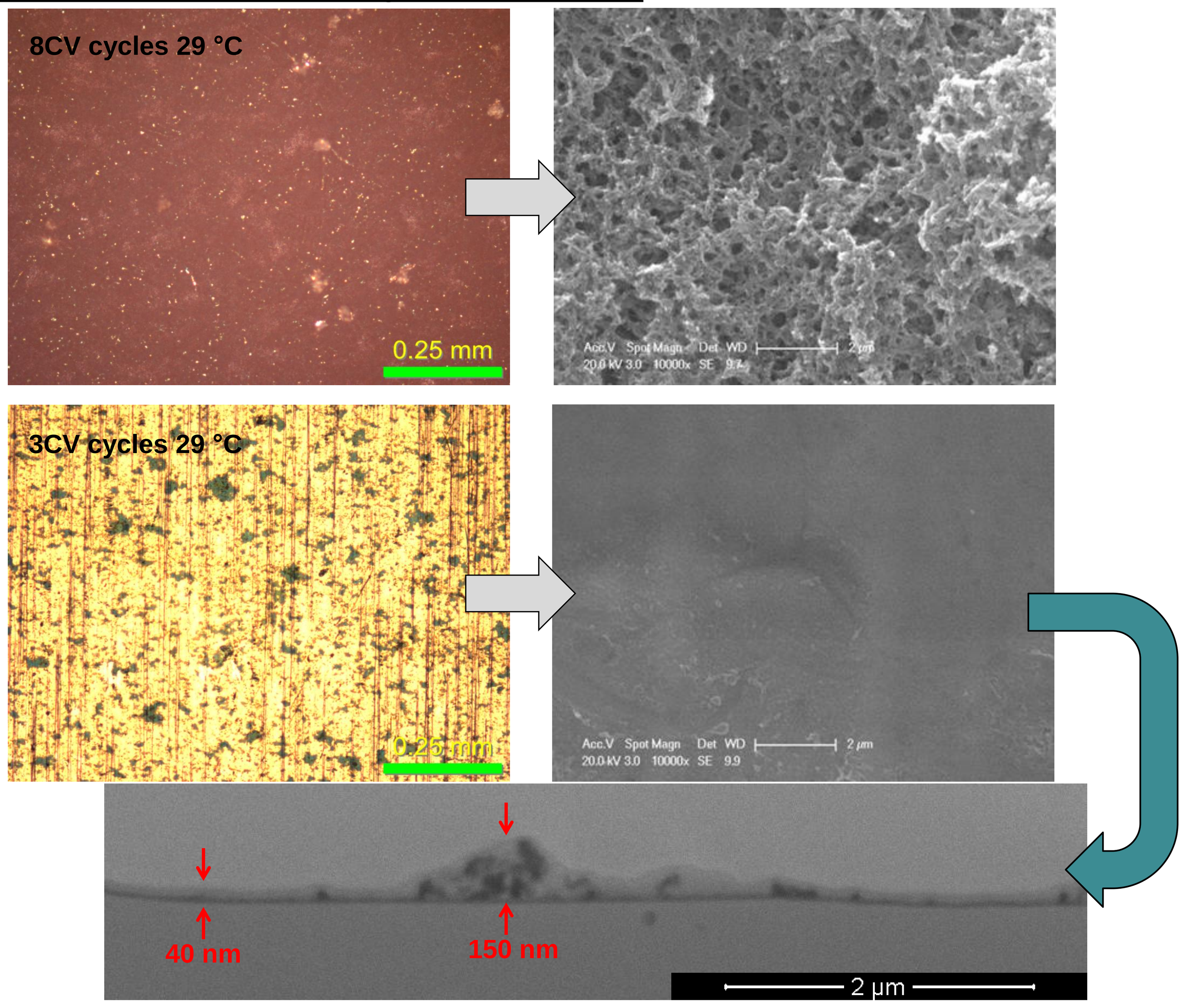
Growth analysis at 3, 15 & 29 °C

$$d = \frac{QMw}{zFA\rho}$$

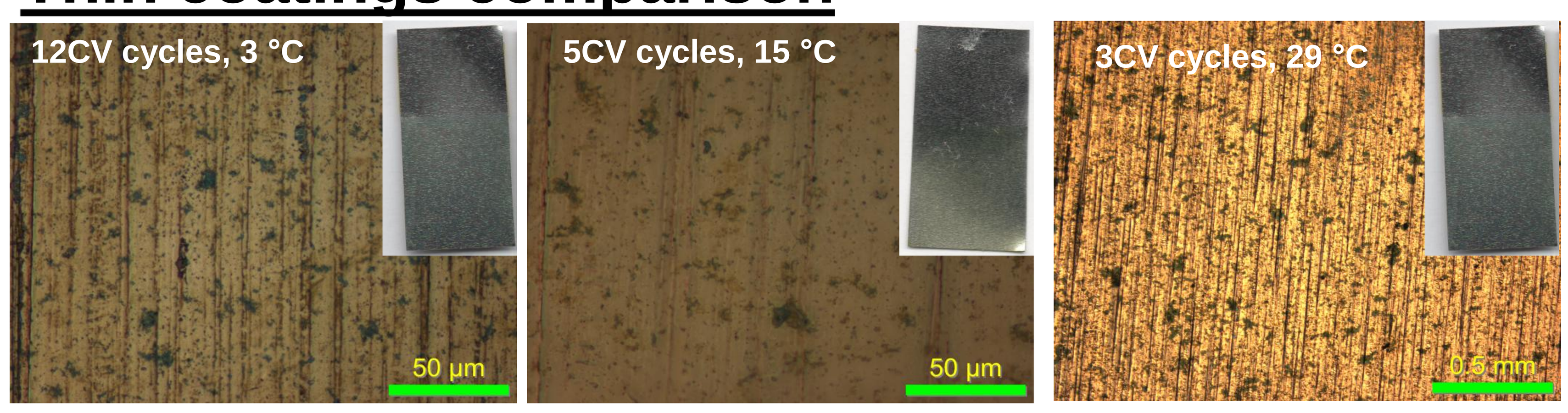
d: estimated coating thickness (nm)
Q: integrated charge of the characteristic peak (mC)
Mw: Aniline molecular weight (93.13 g/mol)
z: No electrons in the polymerization reaction (0.5)
F: Faraday constant
A: electrode area (6.3 cm^2)
ρ: estimated density of the polymer (1.022 g/cm^3)



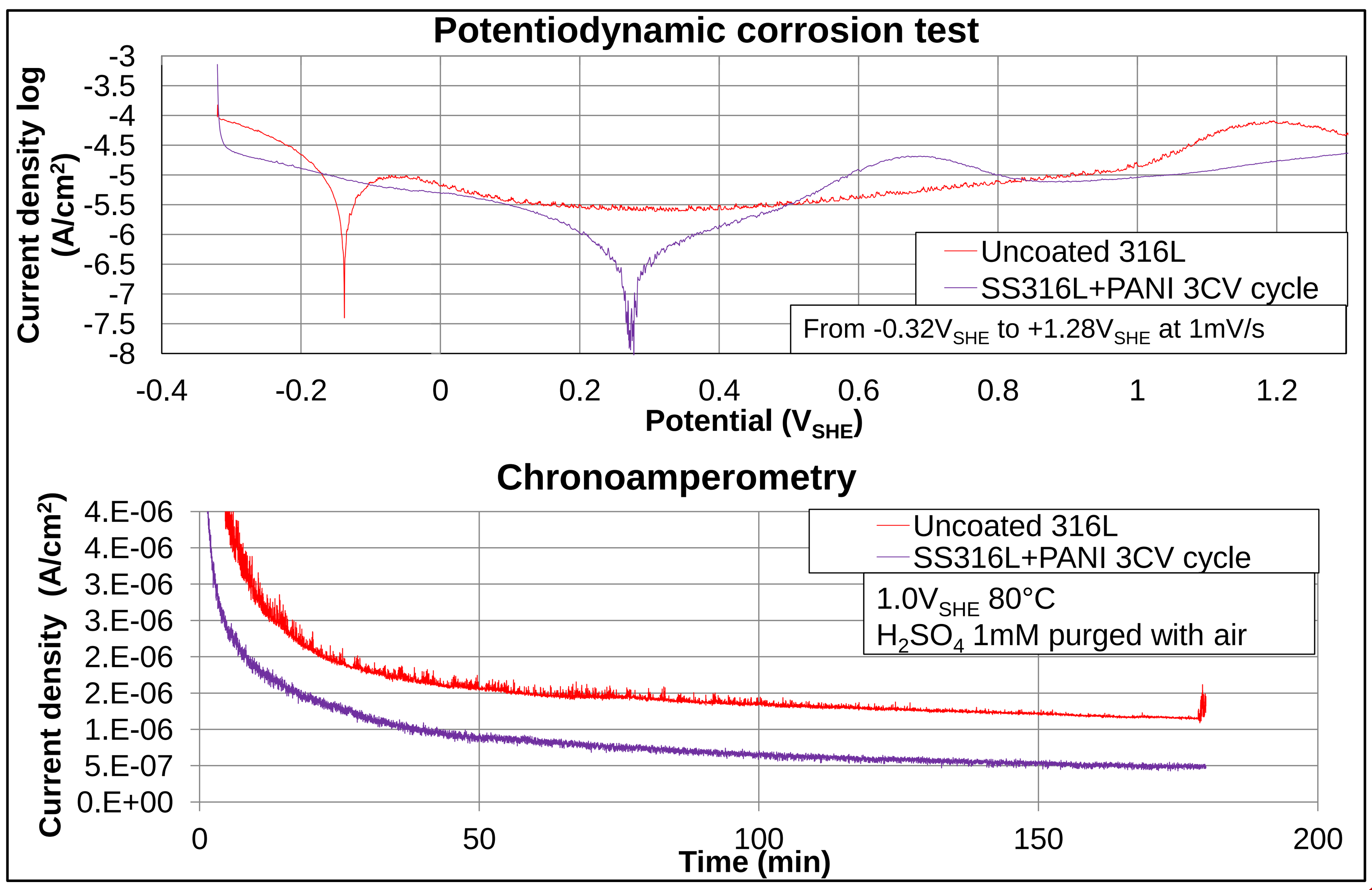
Growth morphology at 29 °C



Thin coatings comparison



Corrosion analysis



Conclusions

- Colder temperatures delays the nucleation of PANI on SS 316L and reduces the growth rate.
- At 29 °C A thin PANI layer is deposited on SS but the polymer tends to form aggregates that leads to porous layers if the coating thickness increases beyond.
- In order to get similar thickness and coating morphology different number of CV cycles are required at 3, 15 and 29 °C.
- Thin PANI layers can decrease the corrosion current in acid electrolyte and positively displace the corrosion potential.

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