



Corrosion resistance of electroless nickel-boron coating in a bath exempt from stabilizer

Muslum YUNACTI

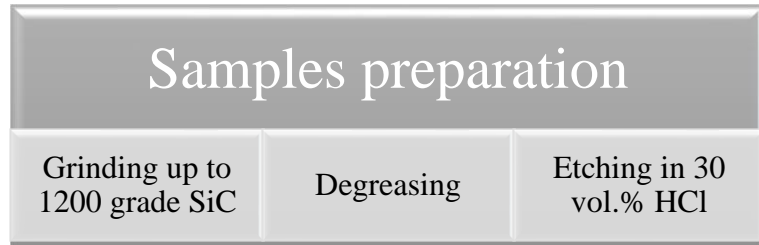
Alexandre Megret

Alex MONTAGNE

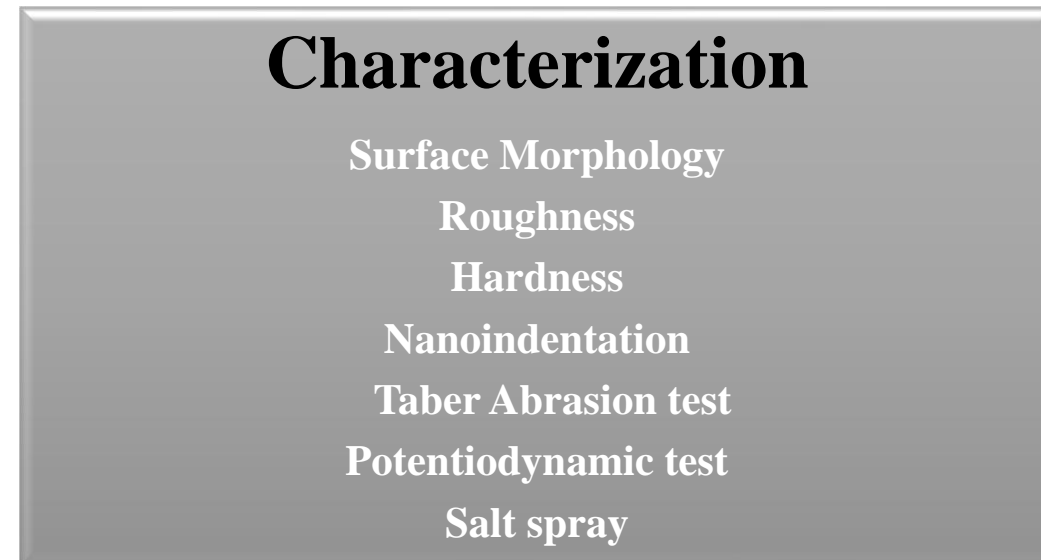
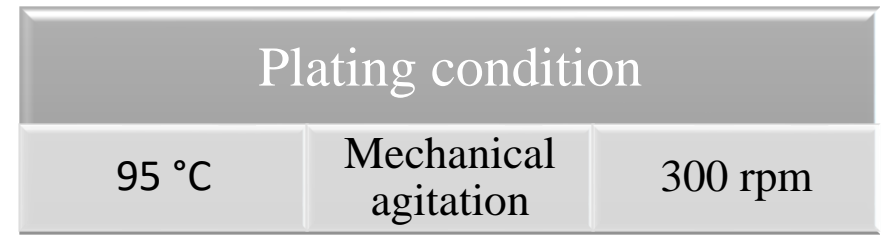
Veronique VITRY



Experiment procedure

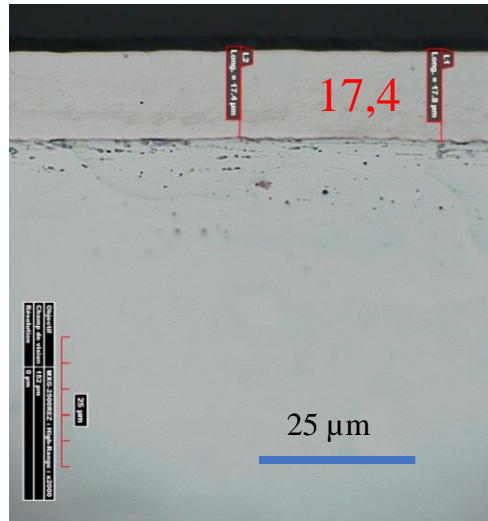


Component	Compound	Quantity
Metallic ions	NiCl ₂ ·6H ₂ O	24 g/L
Reducing agent	NaBH ₄	0.4 g/l
Complexing agent	NH ₂ CH ₂ CH ₂ NH ₂ (ED)	120 l/L
Stabilizer		
pH adjuster	NaOH	160g/L

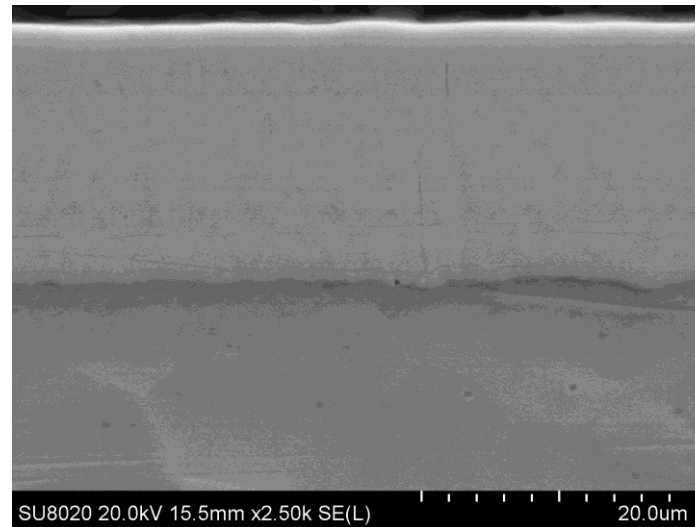


SEM and Optic microscopy results

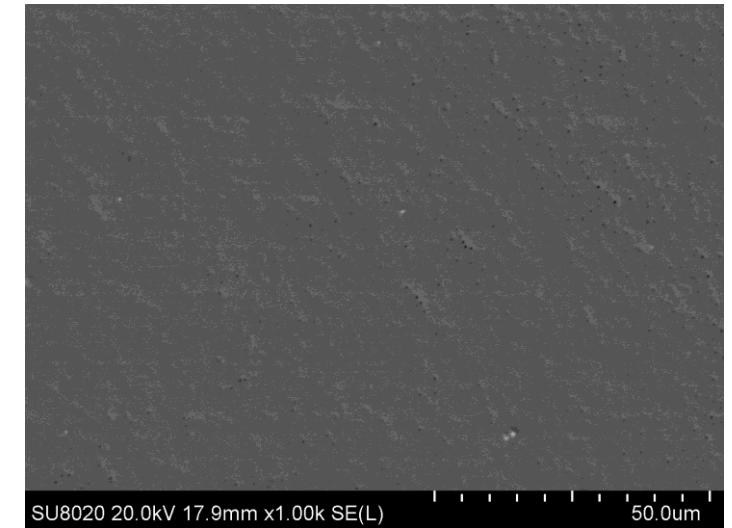
NiB



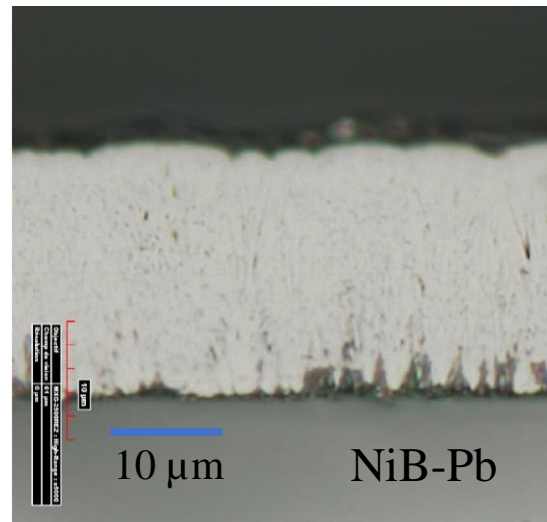
NiB



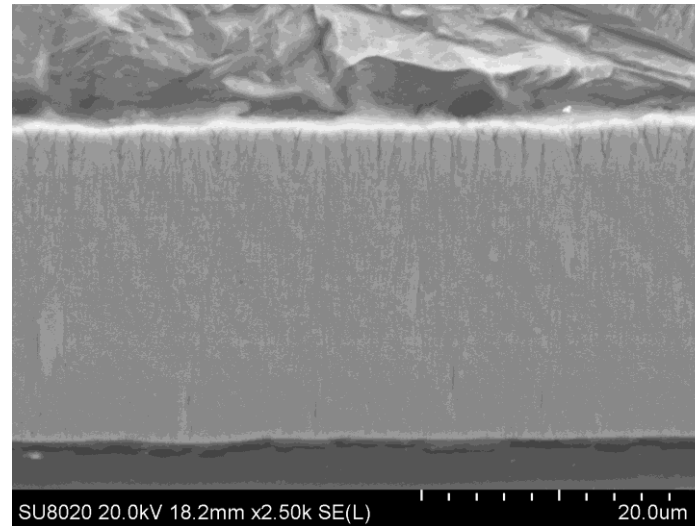
NiB



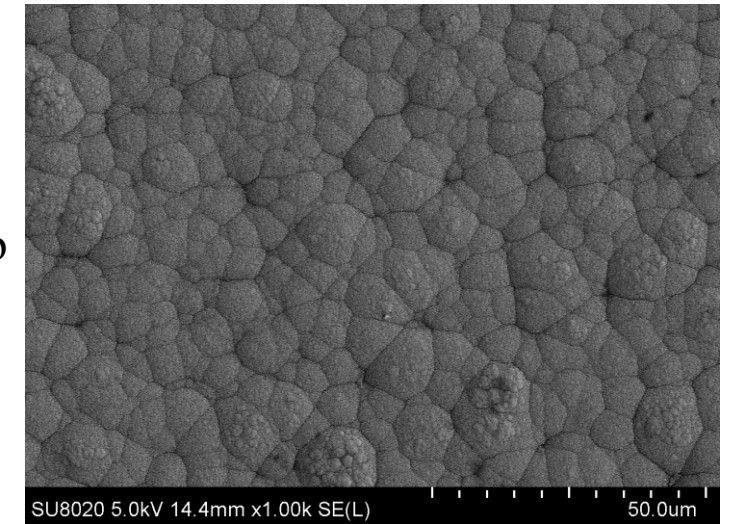
NiB-Pb



NiB-Pb

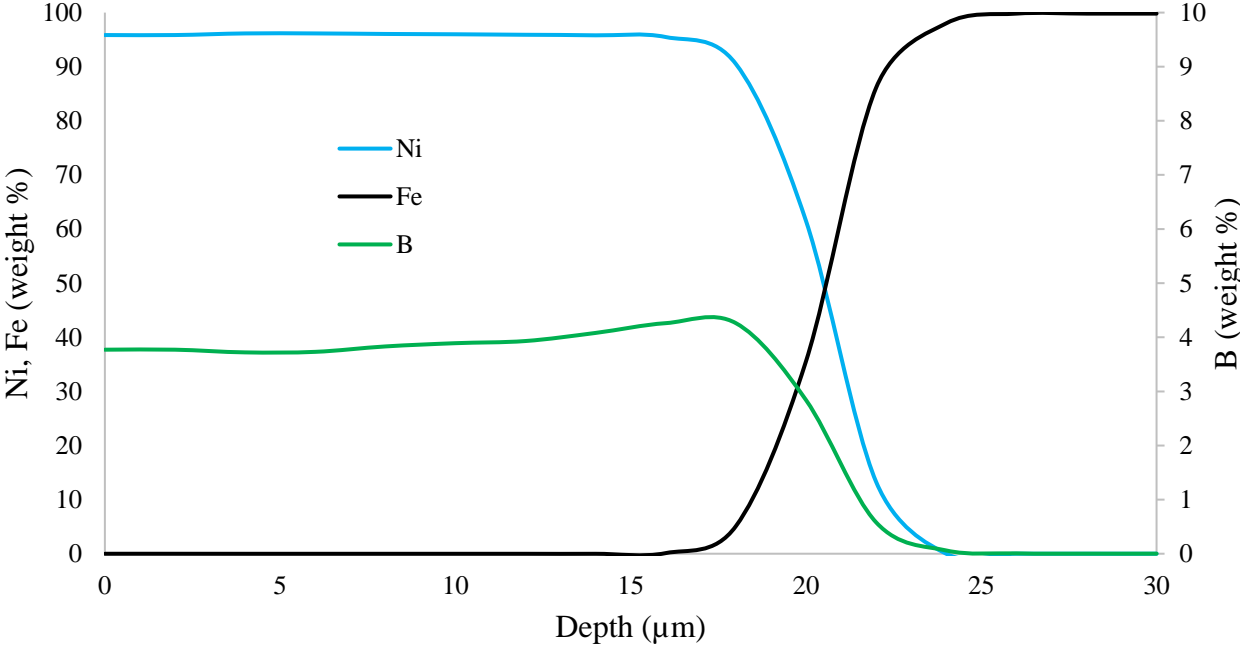


NiB-Pb

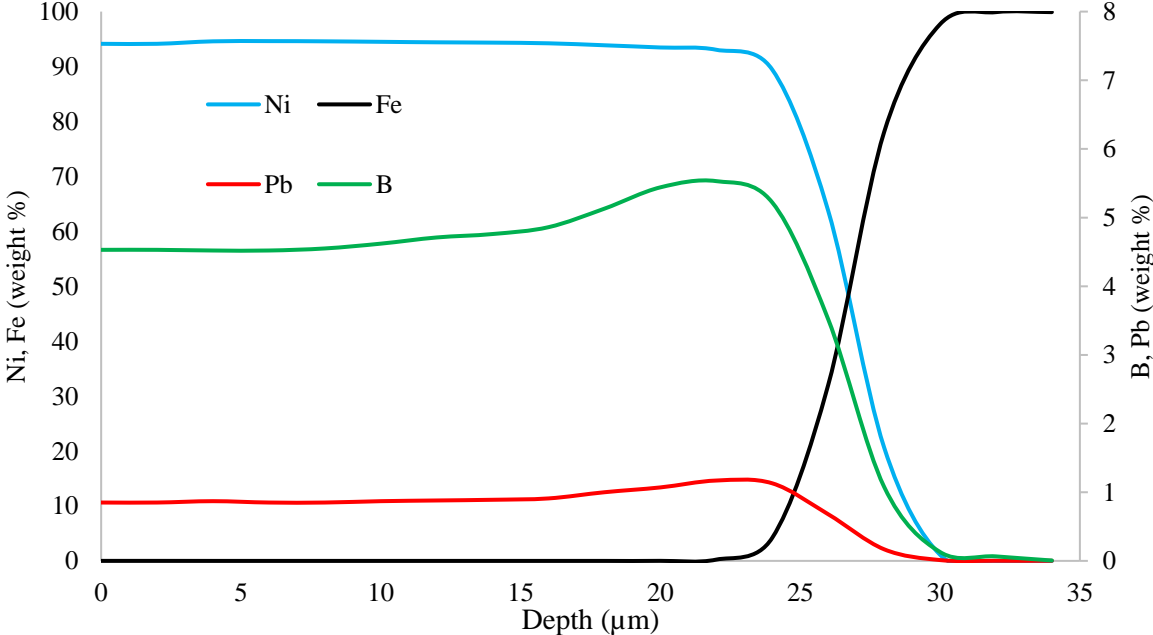


Chemical composition

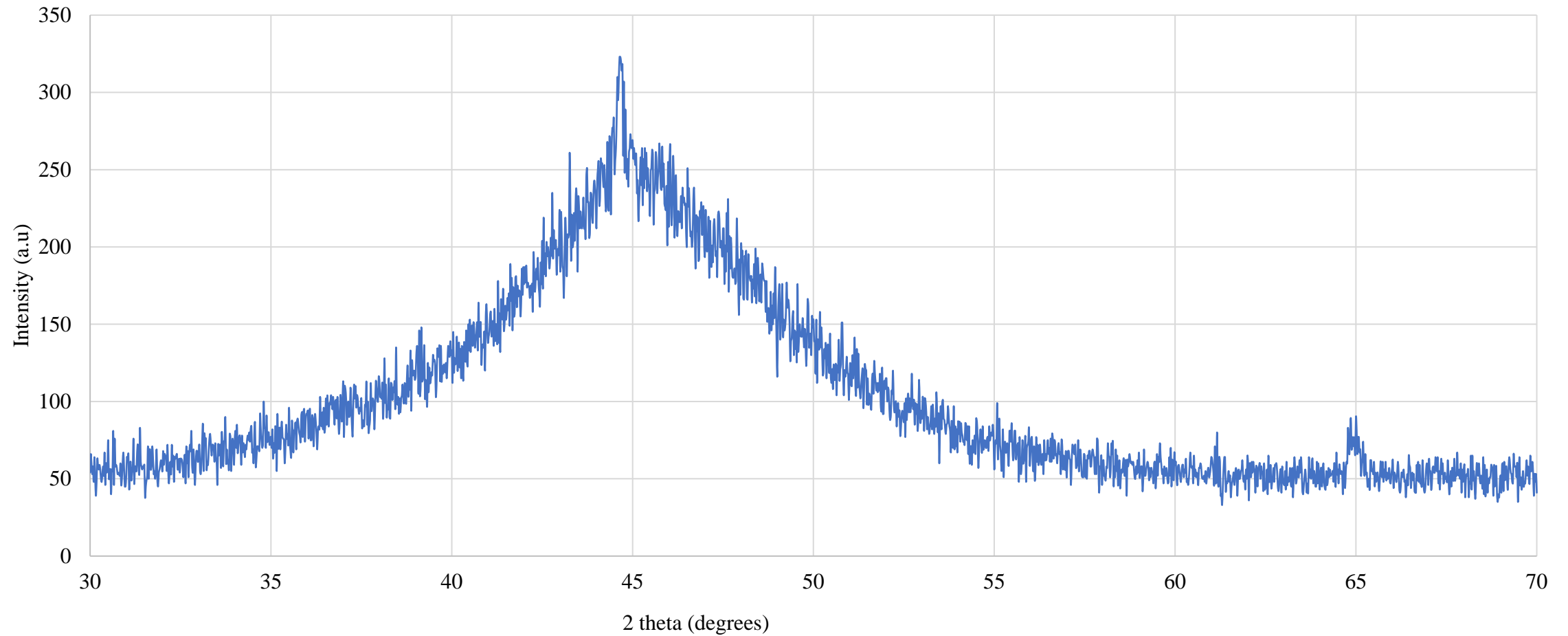
ENB



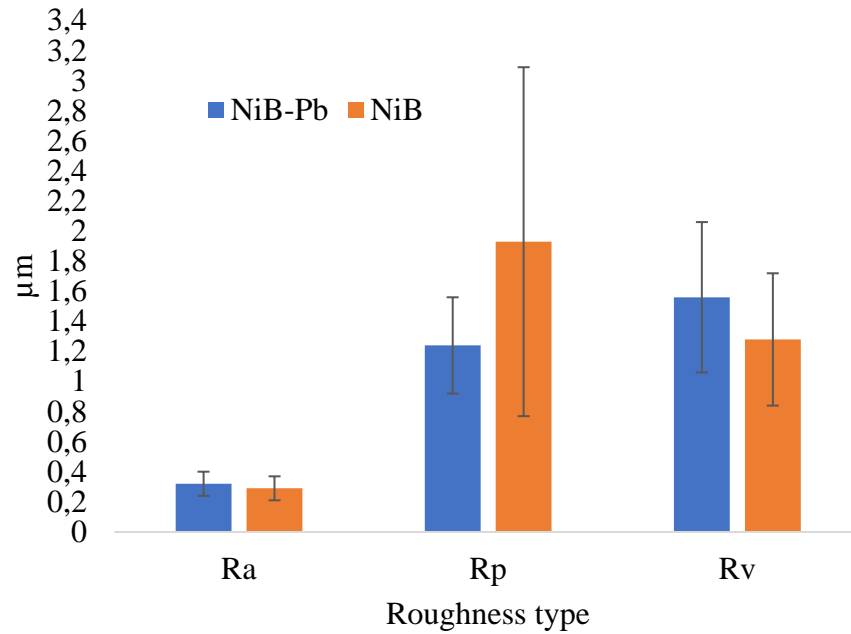
ENB-Pb



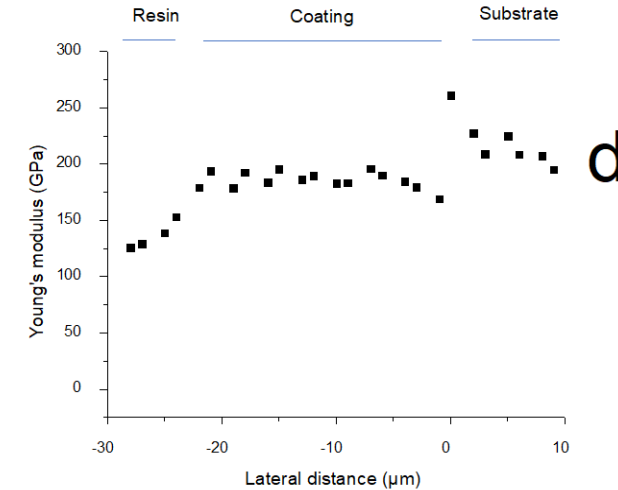
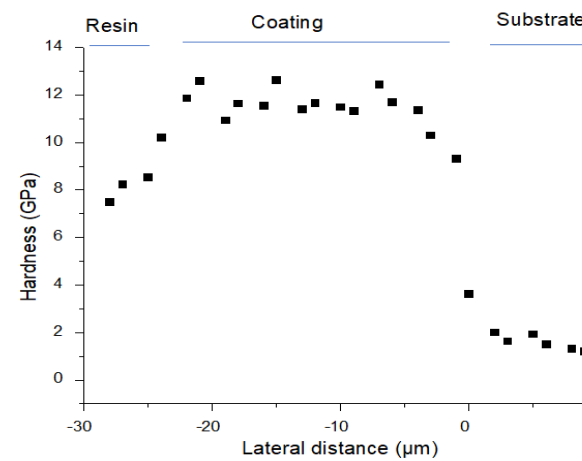
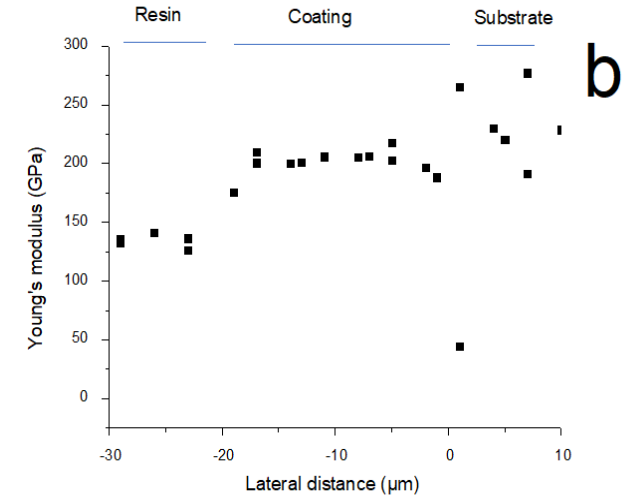
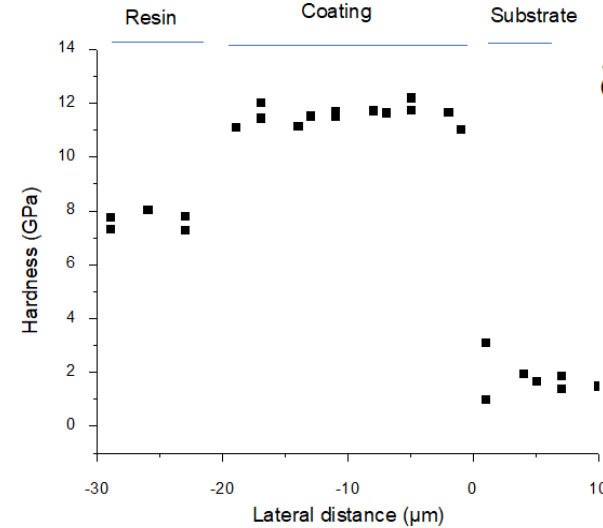
XRD results



Roughness, Vickers and Knoop hardness results

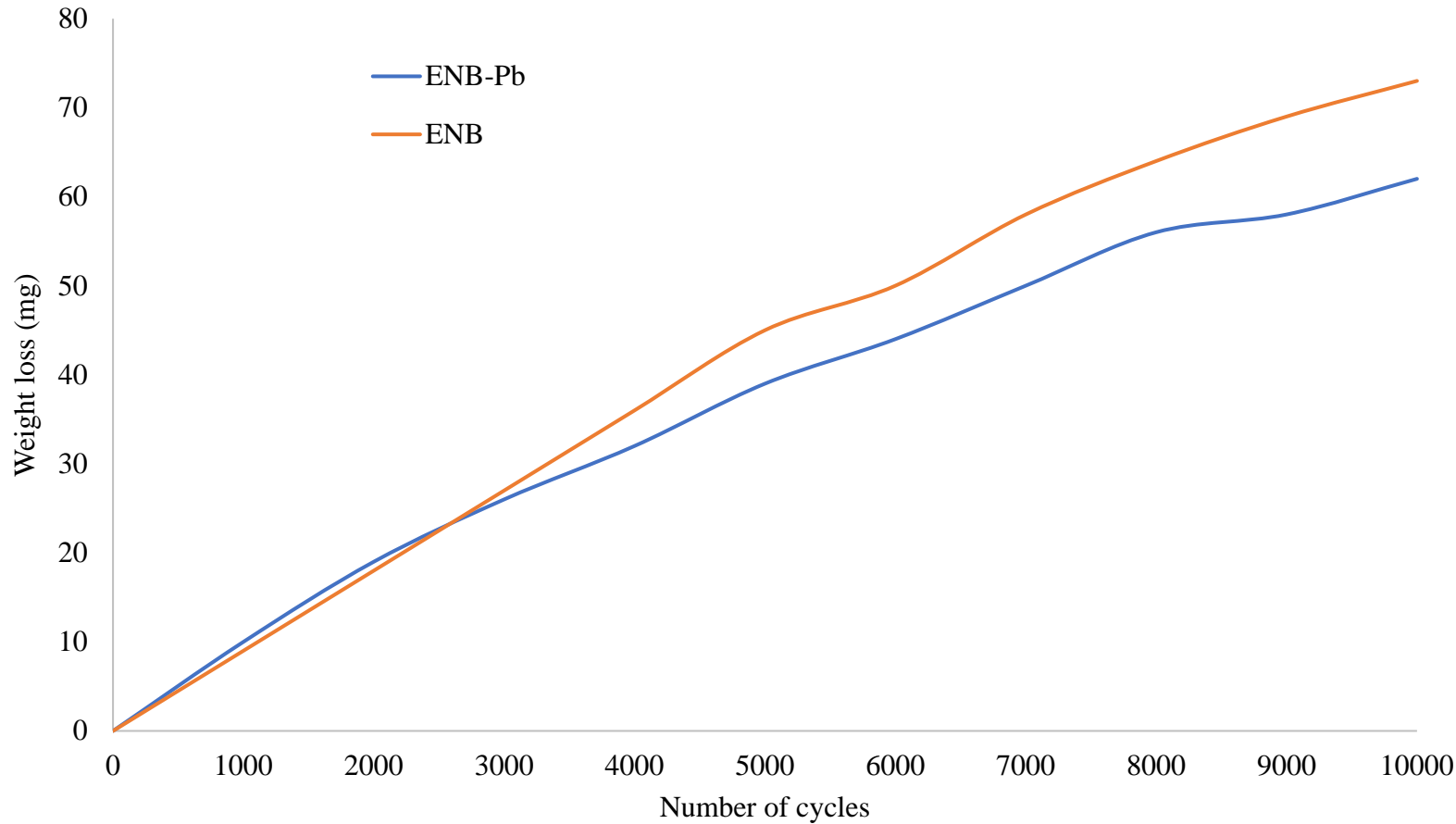


Measurements	ENB	ENB-Pb
Vickers hardness (h_{v50})	933 ± 62	896 ± 57
Knoop hardness (h_{k50})	886 ± 30	892 ± 87
Hardness IIT (GPa)	11.6 ± 0.3	11.5 ± 0.7
Elastic Modulus (GPa)	201 ± 10	185 ± 10



Hardness (a) and Young's modulus (b) of the ENB deposit, hardness (c), and modulus (d) of the ENB-Pb deposit

Taber Abrasion Resistance



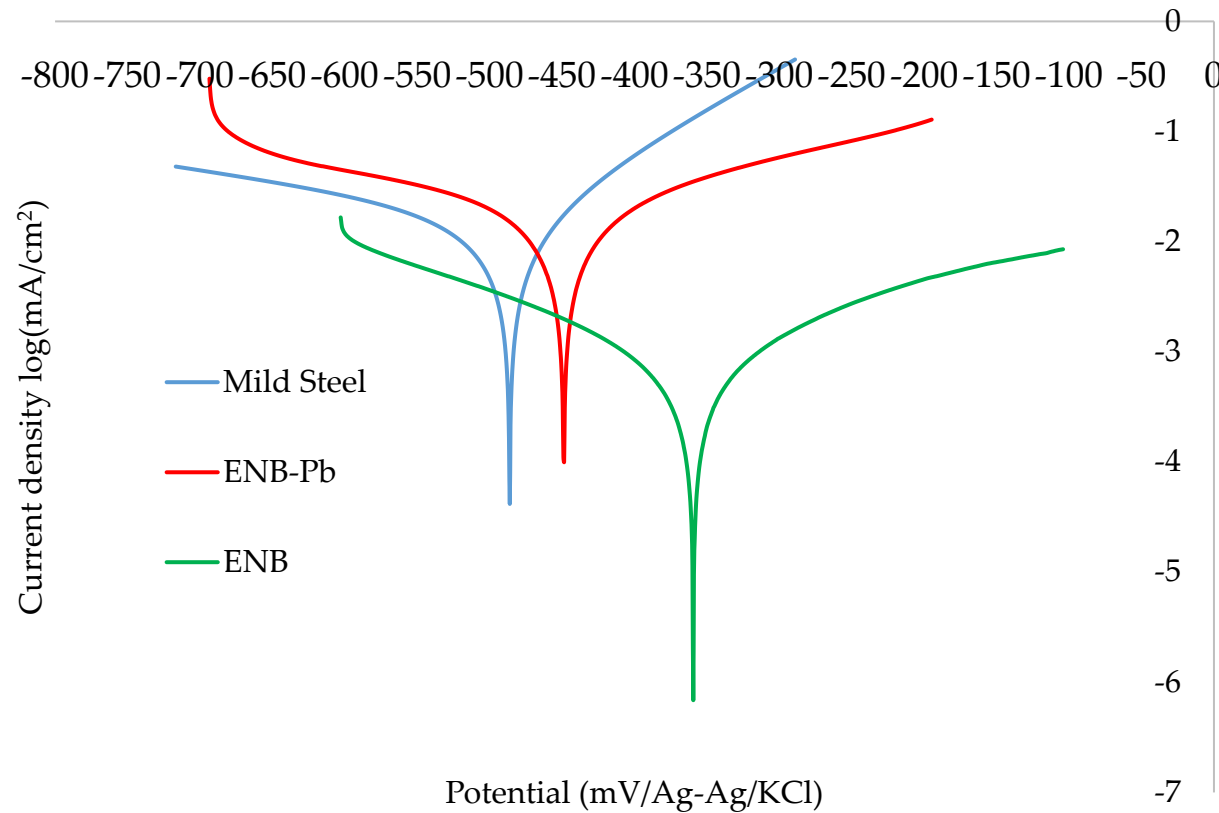
The operating conditions for the test are:

- Load: 1000 g
- Speed: 72 rpm
- Number of cycles: 10 * 1000, weighting every 1000 cycles
- Wheels: CS-10

$$TWI = \frac{\text{weight loss (mg)}}{\text{number of 1000 cycles}}$$

Deposit	TWI
ENB	7.3
ENB-Pb	6.2

Potentiodynamic Polarization Results

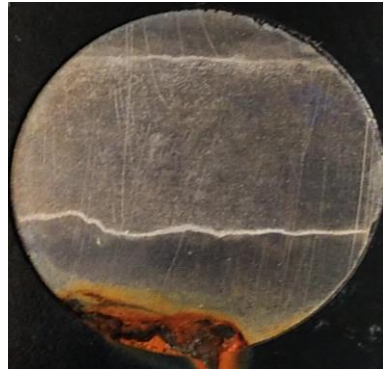


Parameter	Input
Counter electrode	Platinum
Reference electrode	Ag/AgCl (KCl saturated)
Potential range	± 0.25 V vs OCP
Scan rate	1 mV/s
Electrolyte	0.1 M NaCl

Salt Spray Result

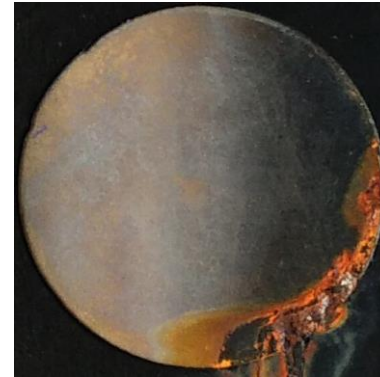
NiB

168 h



NiB-Pb

168 h



Substrate (mild steel)

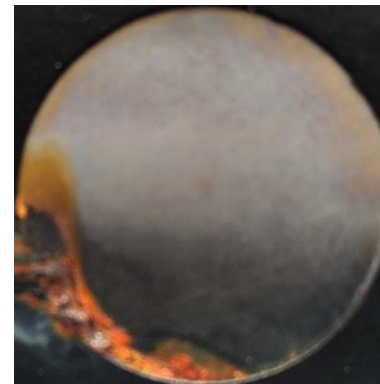
168 h



220 h



220 h



220 h



Corrosion test result

- More positive corrosion potential than the substrate and the ENB-Pb deposit
- Slower corrosion rate in salt spray test
- Chemically homogeneity
- Smooth surface
- Absence of columnar structure

Conclusion

- Stabilizer-free bath
- Toxic heavy metal
- The new deposit has:
 - ✓ Modified deposit composition
 - ✓ Similar mechanical properties with the conventional electroless nickel-boron deposit
 - ✓ The same abrasion resistance
- The new deposit has better corrosion resistance than the conventional electroless nickel-boron deposit



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