An investigation of wind turbine blade erosion due to rain and weathering

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Contents

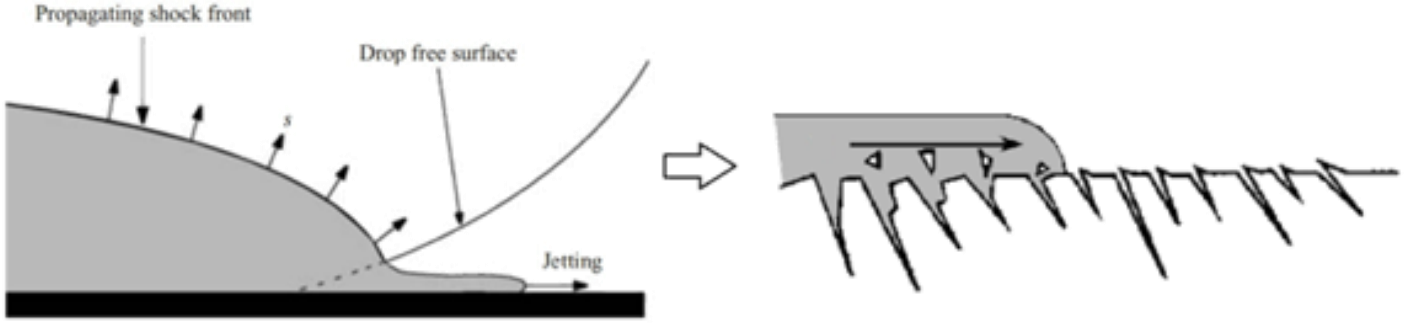
- The Problem
- Project details
- Experiments/Results
- Ongoing/future work

The Problem

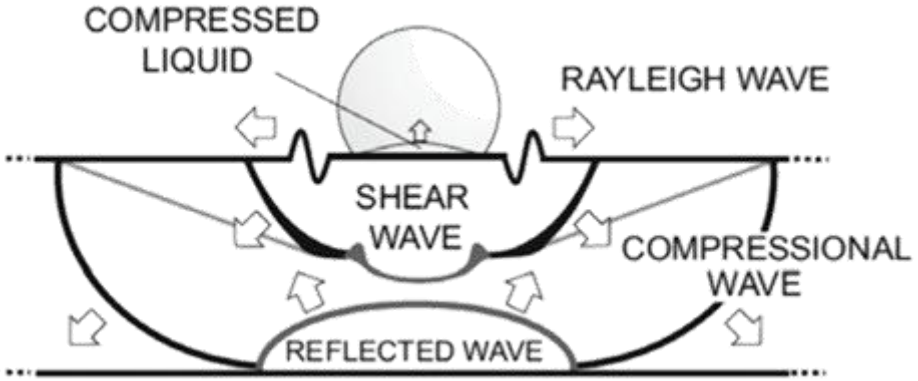
Wind turbine blade surfaces are eroded by environmental degradation factors.

Degradation mechanisms for the erosion of blade coatings are not fully understood.

—Based upon Springer Fatigue Model (1976)



Valaker, E., Armada, S. and Wilson, S. (2015). Droplet Erosion Protection Coatings for Offshore Wind Turbine Blades.



Blade Erosion

Erosion Progression

Project Plan

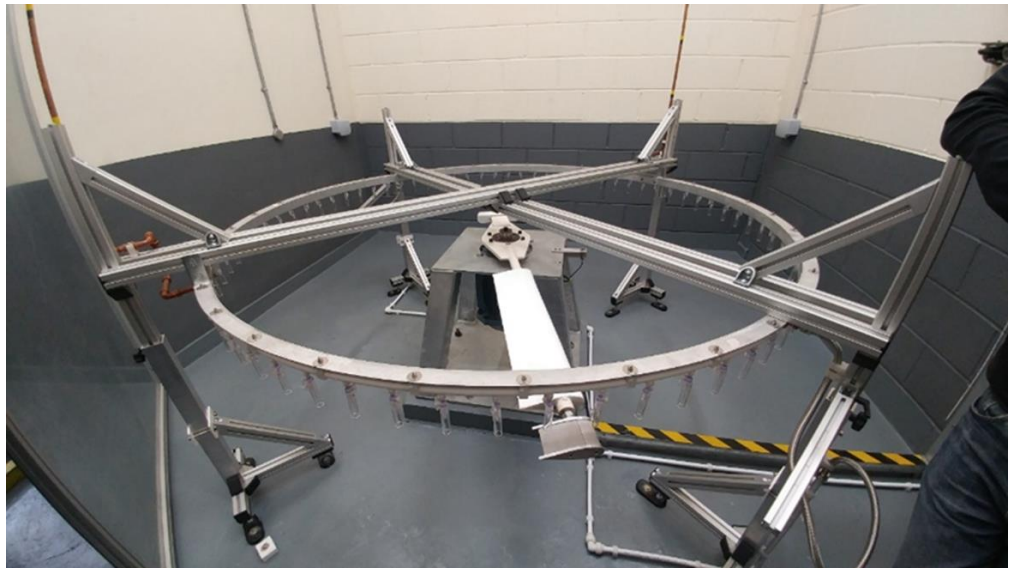
Three work packages identified.

WP 1 – Rain

WP 2 – Weathering

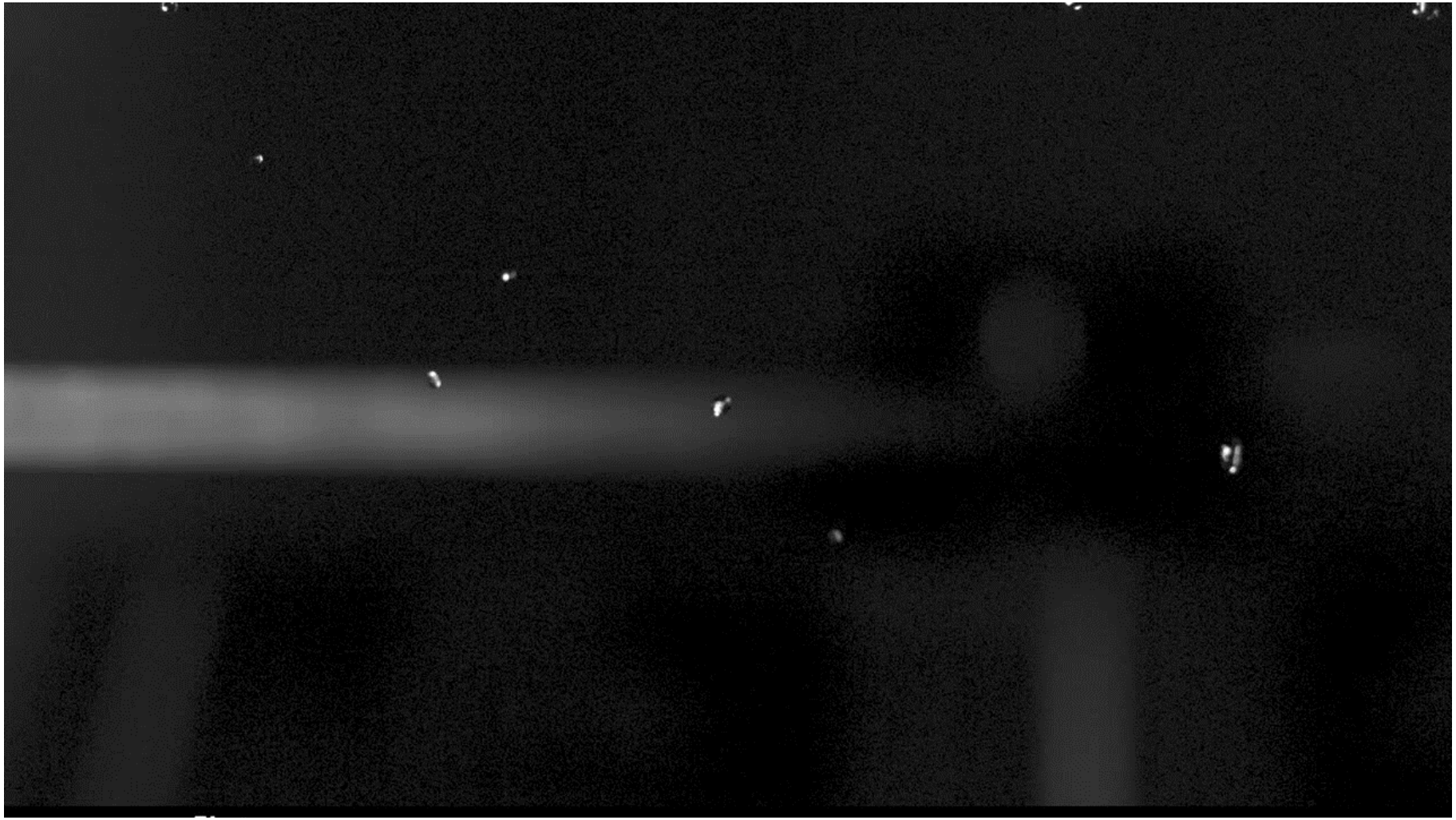
WP 3 – Rain + Weathering

Accelerated Rain Erosion

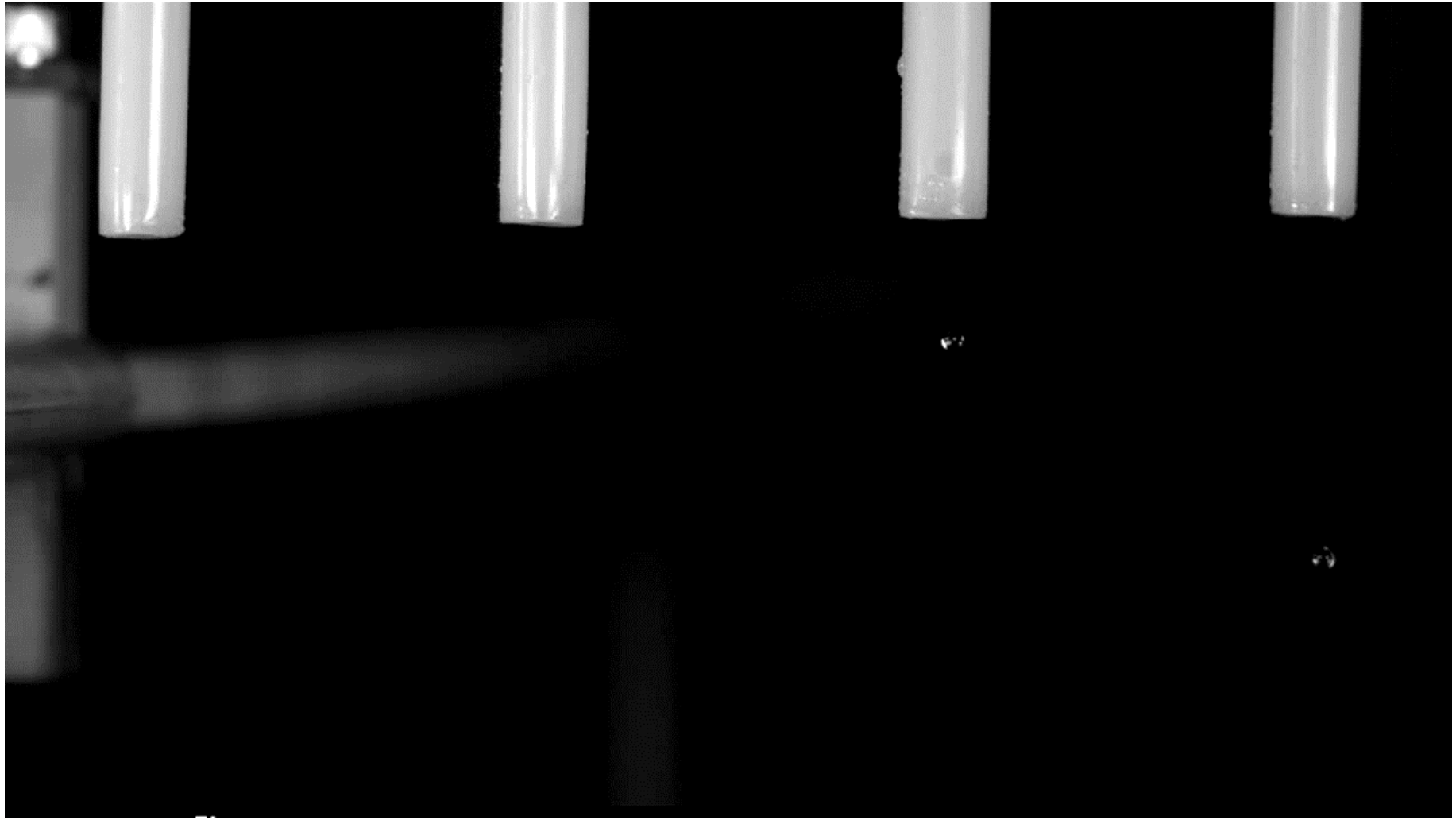


- 72 Needles
- Up to 1400rpm
- Changeable droplet rate, size and height
- 30 minutes from Strathclyde

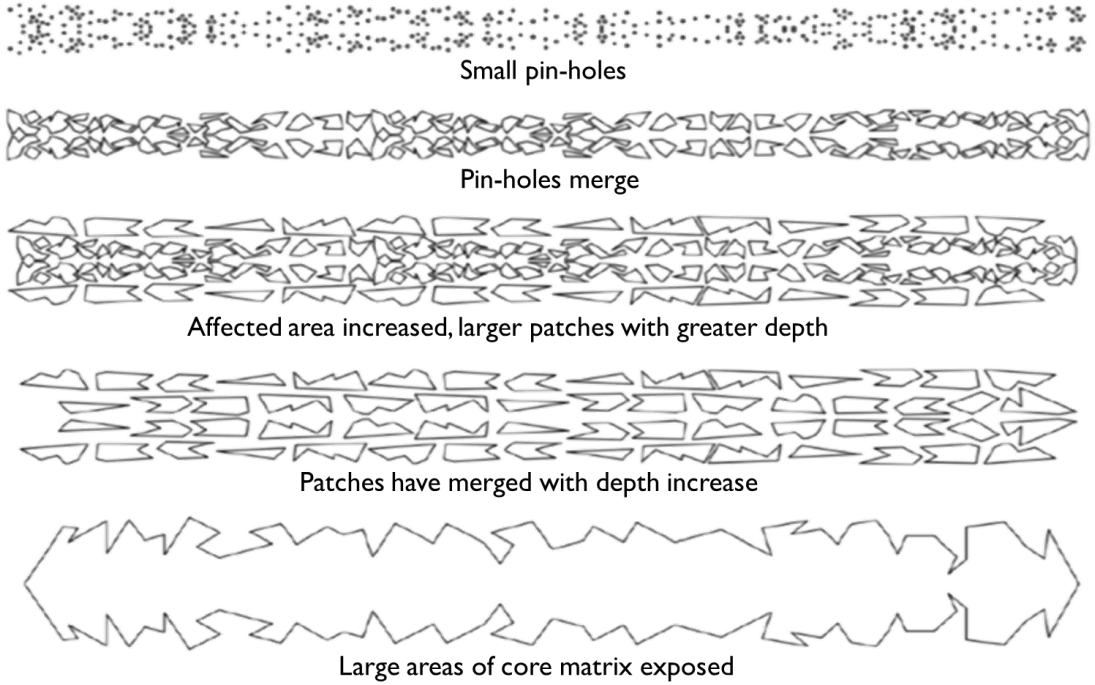
High Speed Camera Footage



High Speed Camera Footage

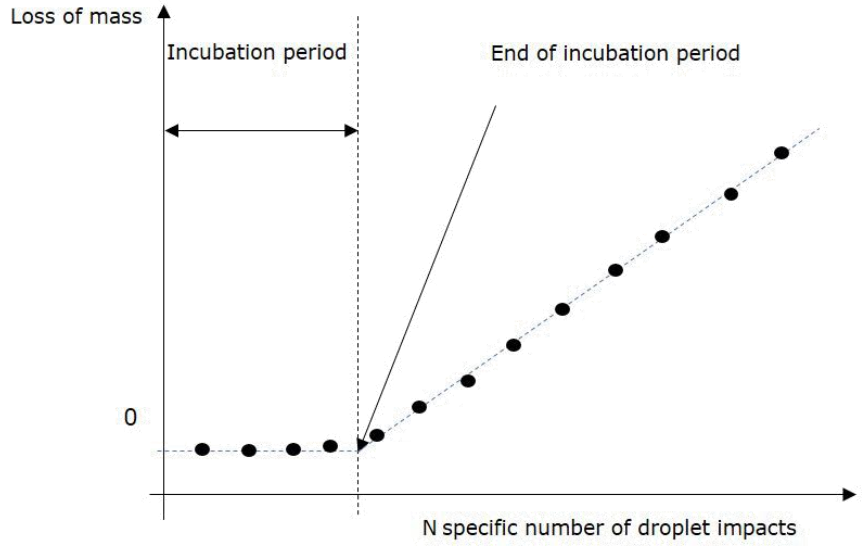


Typical erosion stages

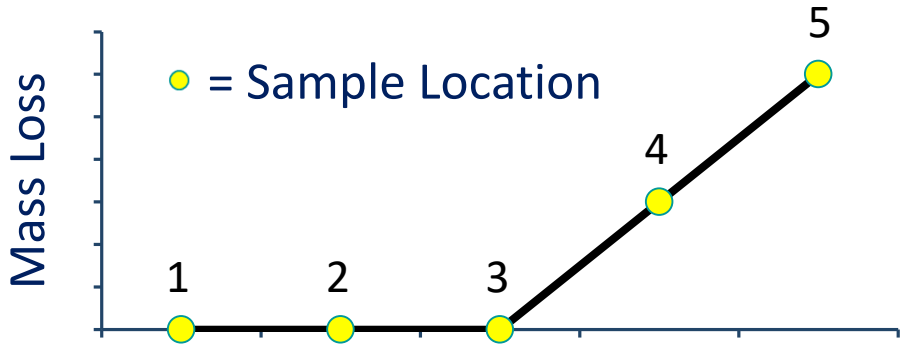


(Vestas) Gaudern, N. (2014). A practical study of the aerodynamic impact of wind turbine blade leading edge erosion.

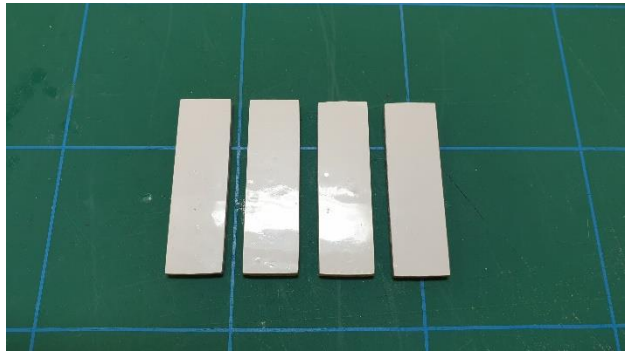
- Increase in C_D
- Decrease in C_L



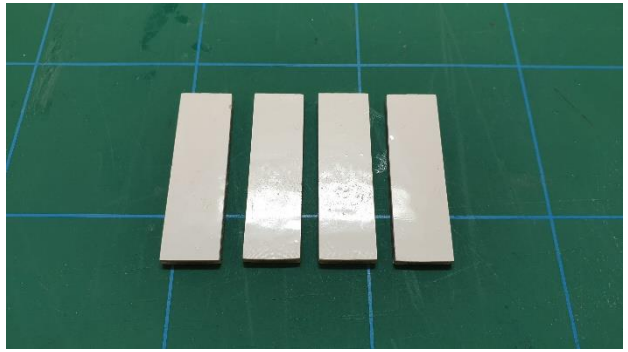
Erosion Progression



Rain Eroded Test Specimens



Stage 1



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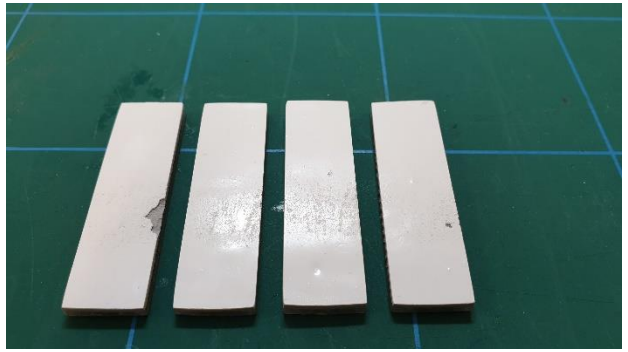

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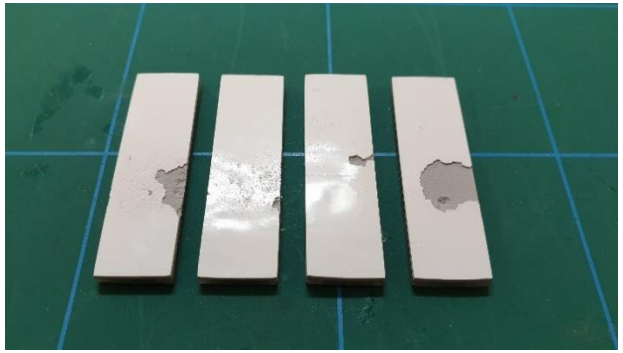
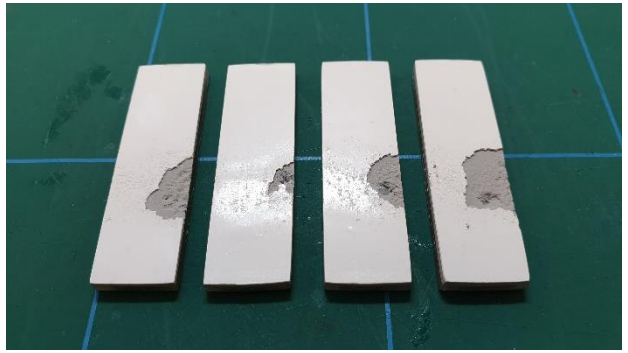
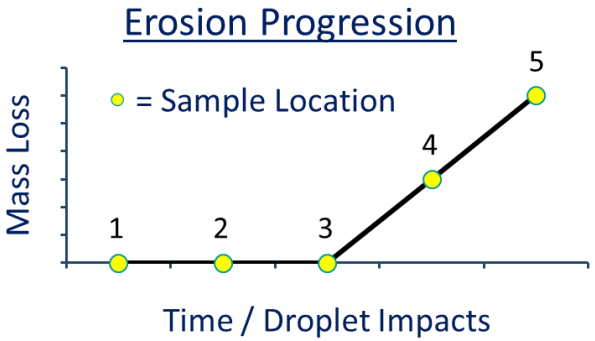


Stage 4



Stage 5



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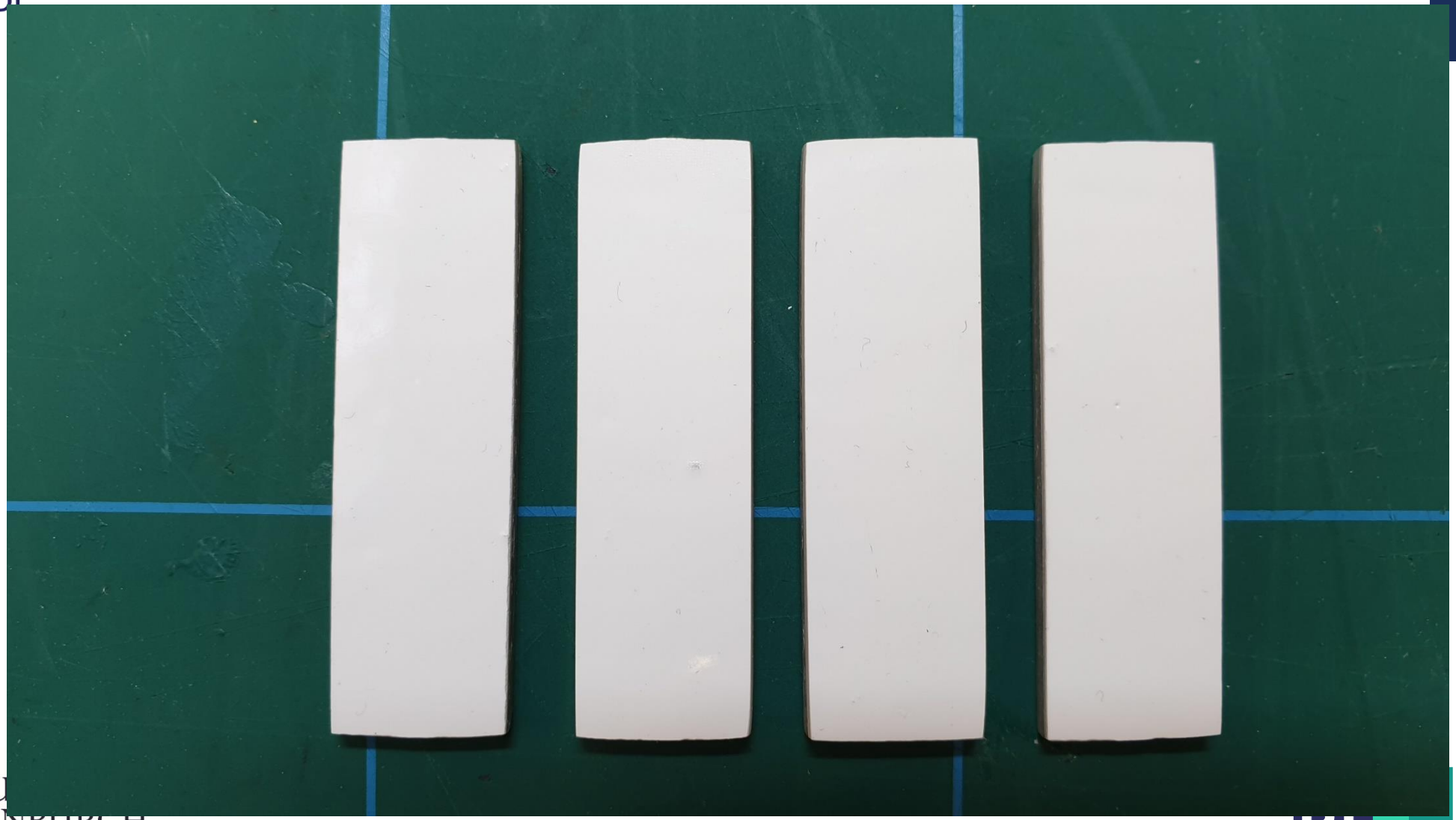

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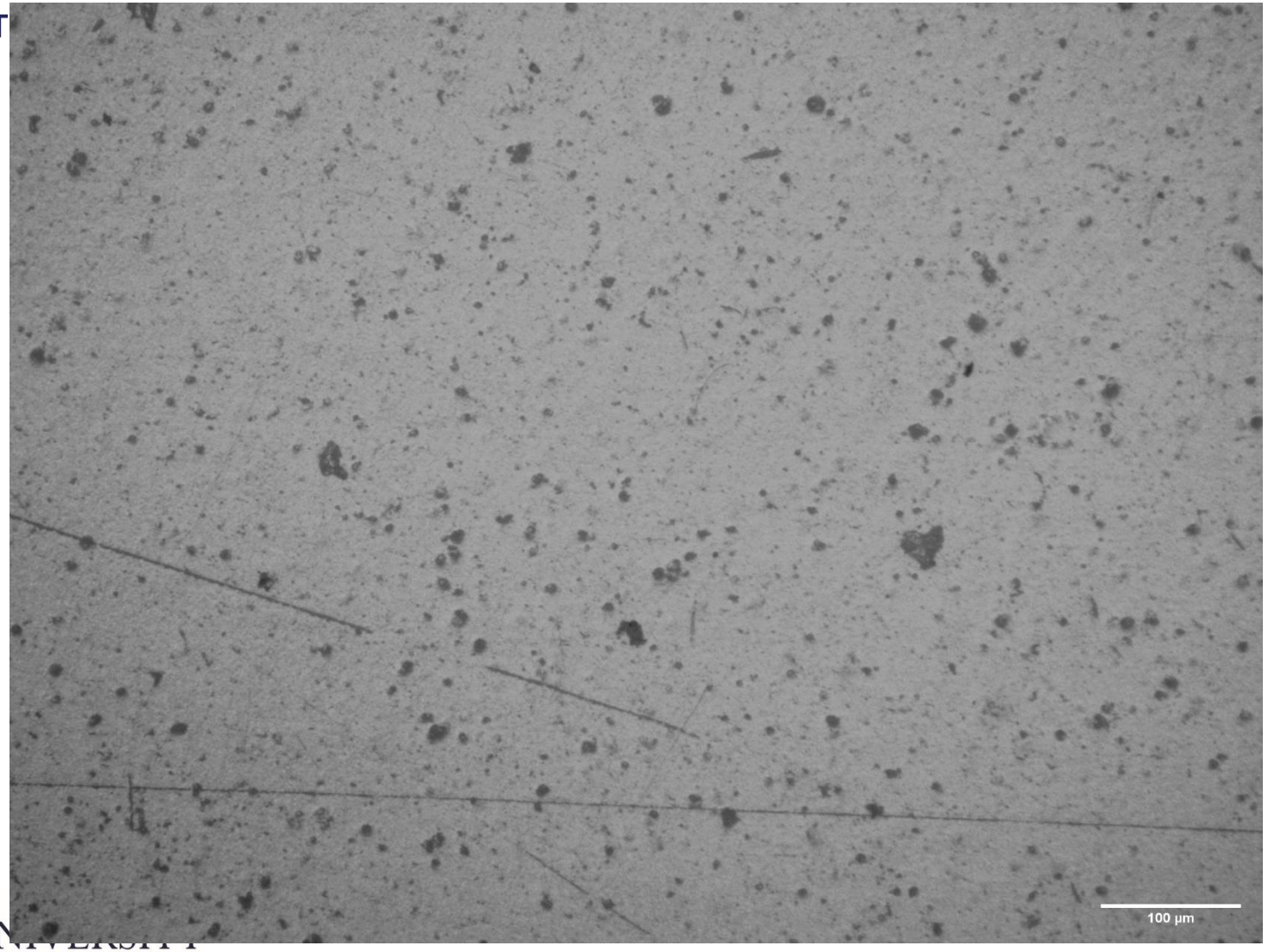

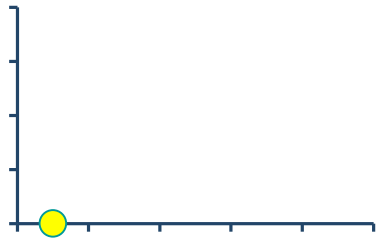

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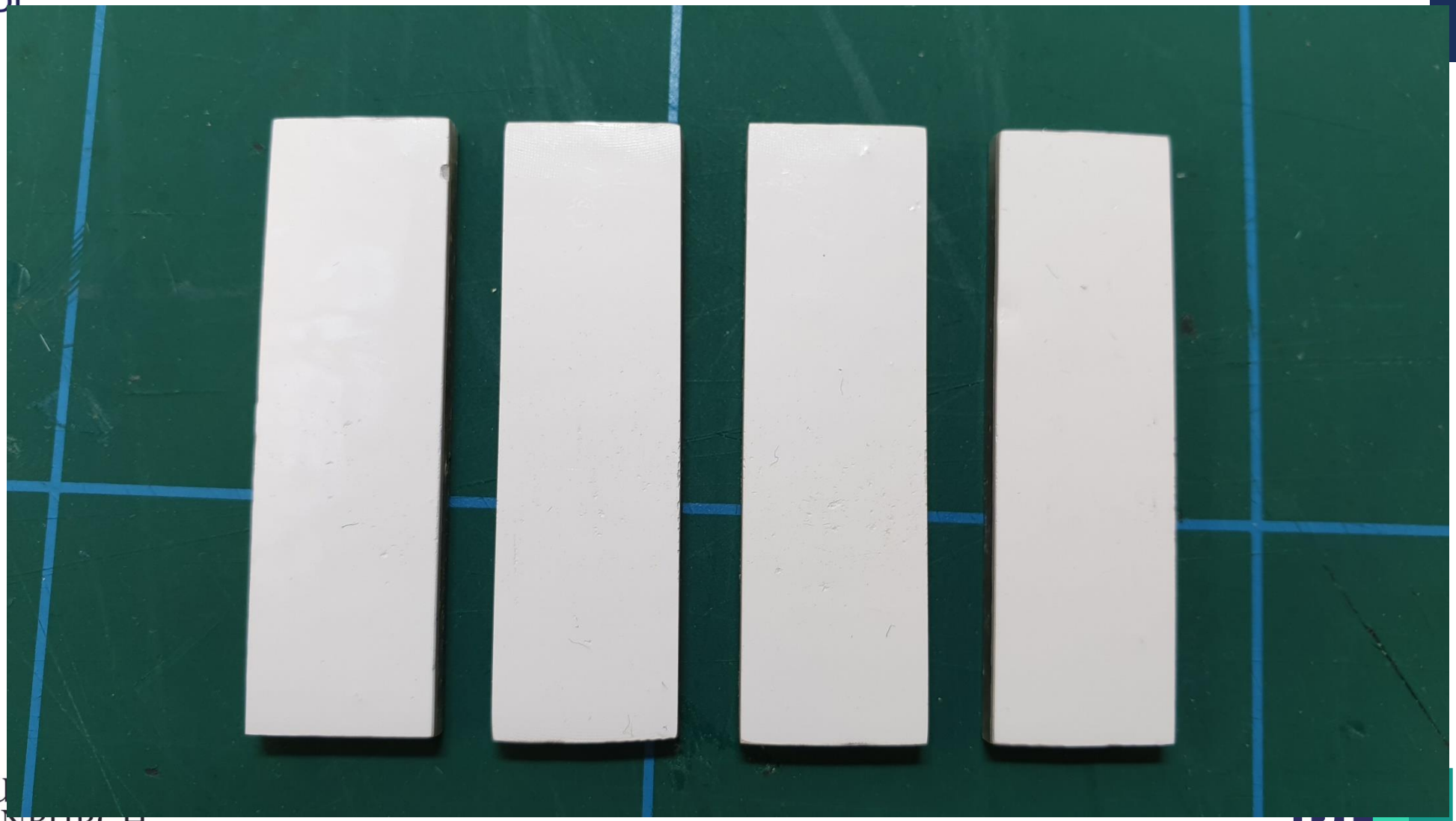

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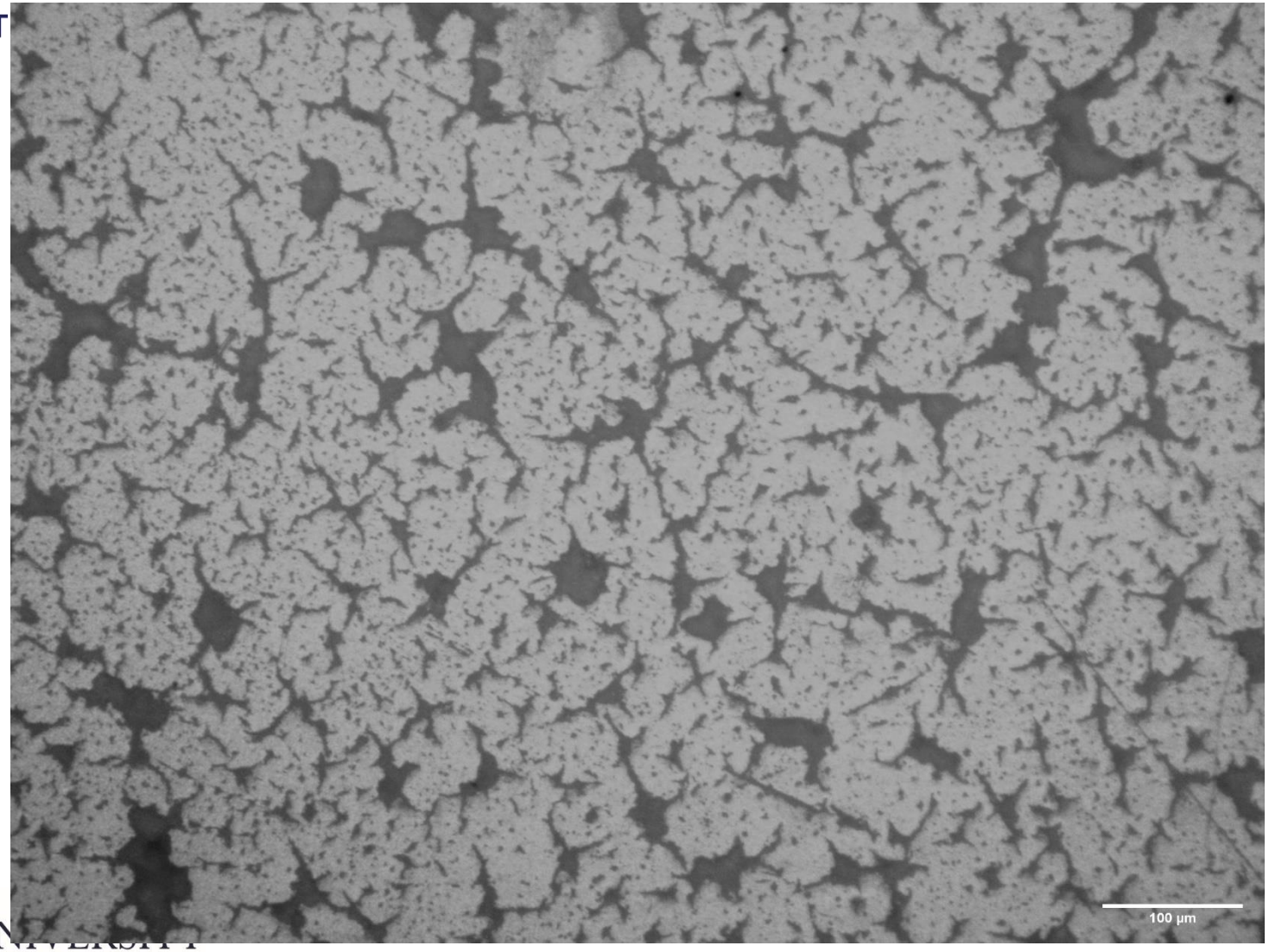

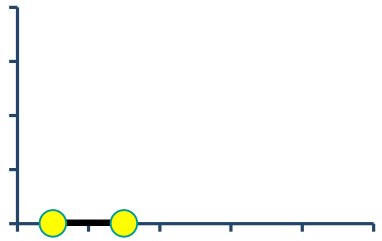

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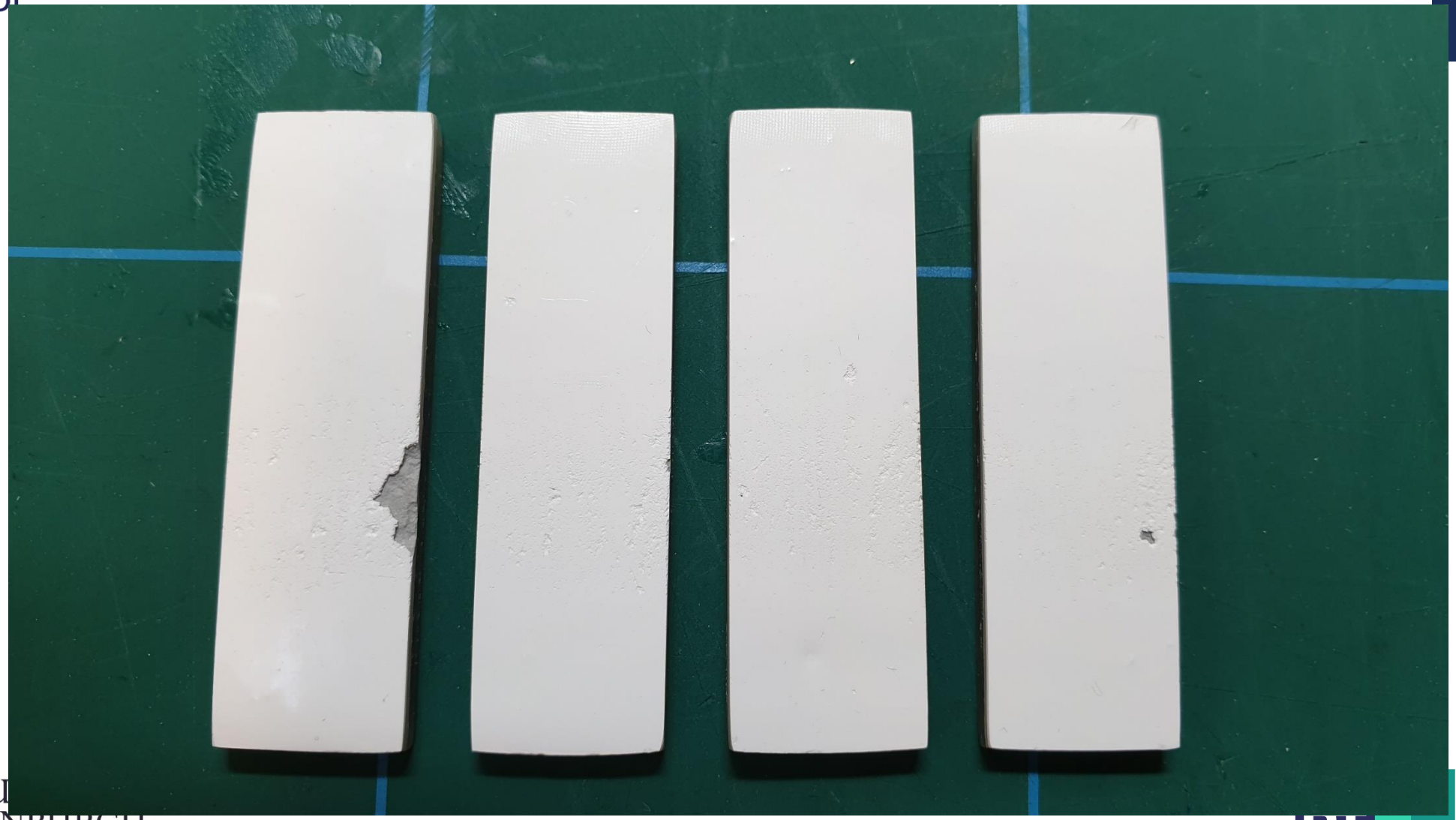

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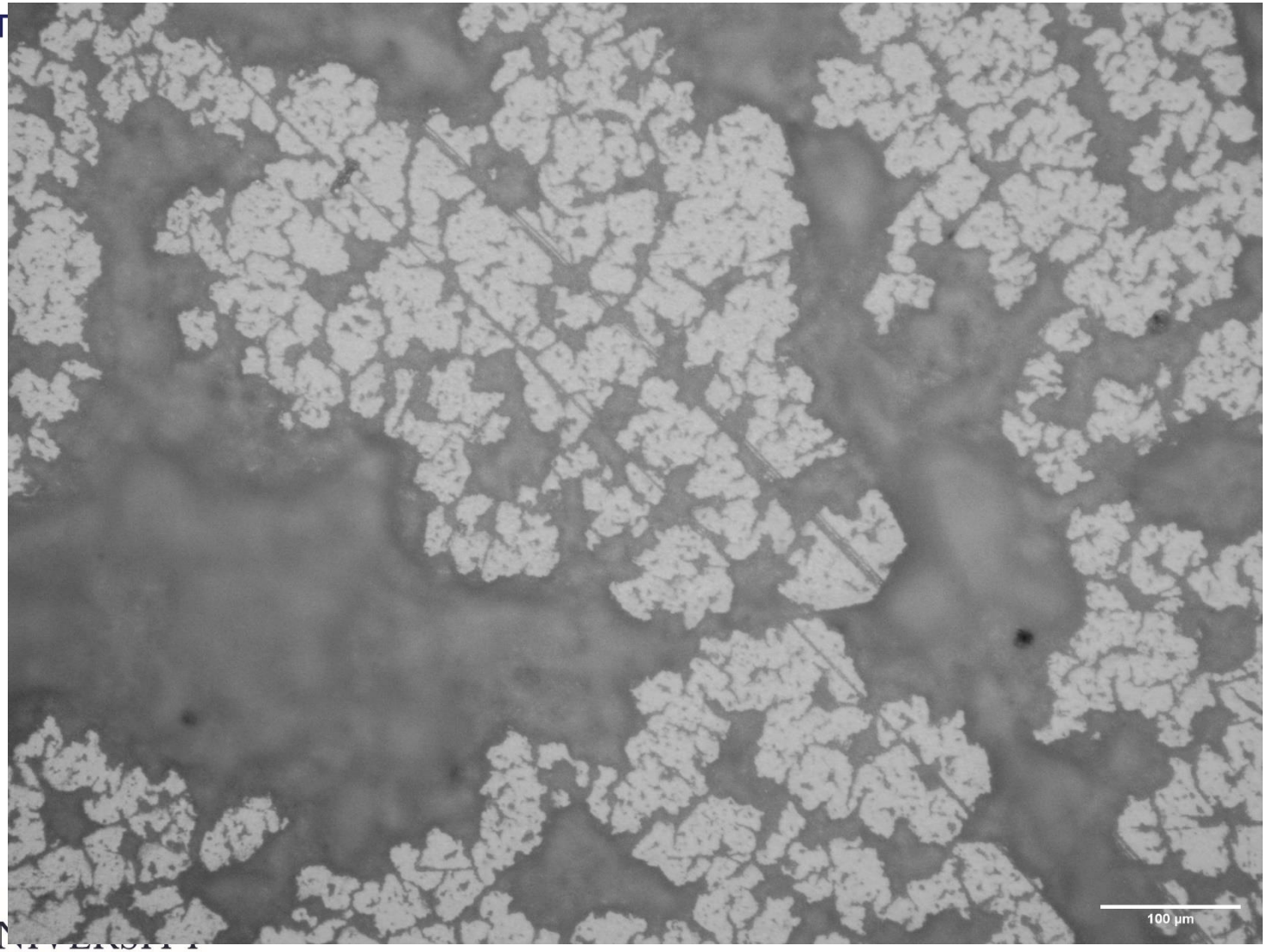

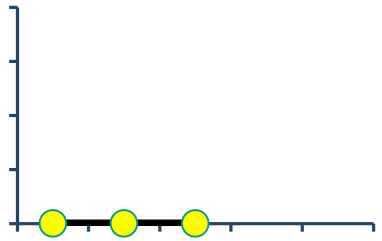

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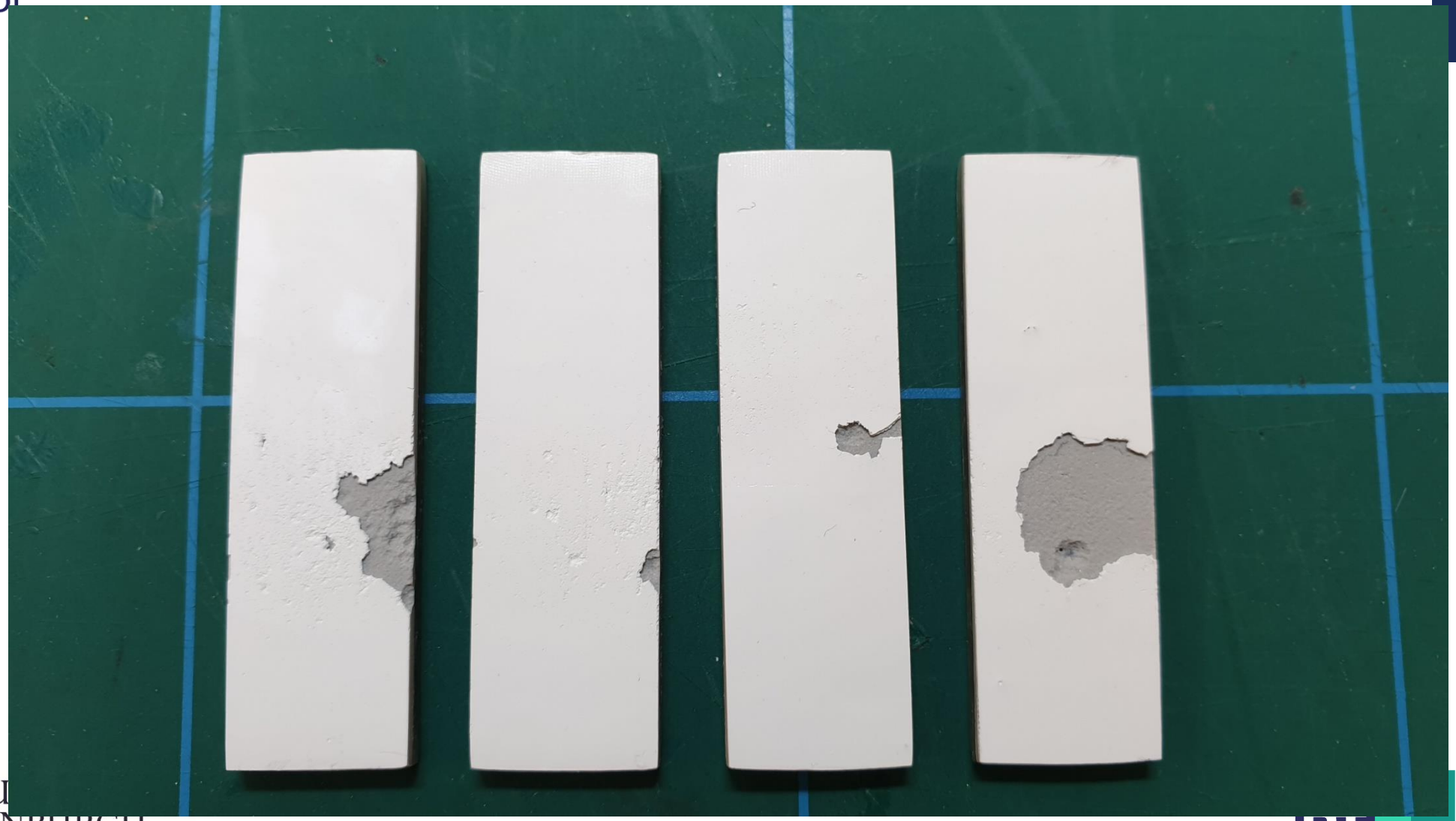

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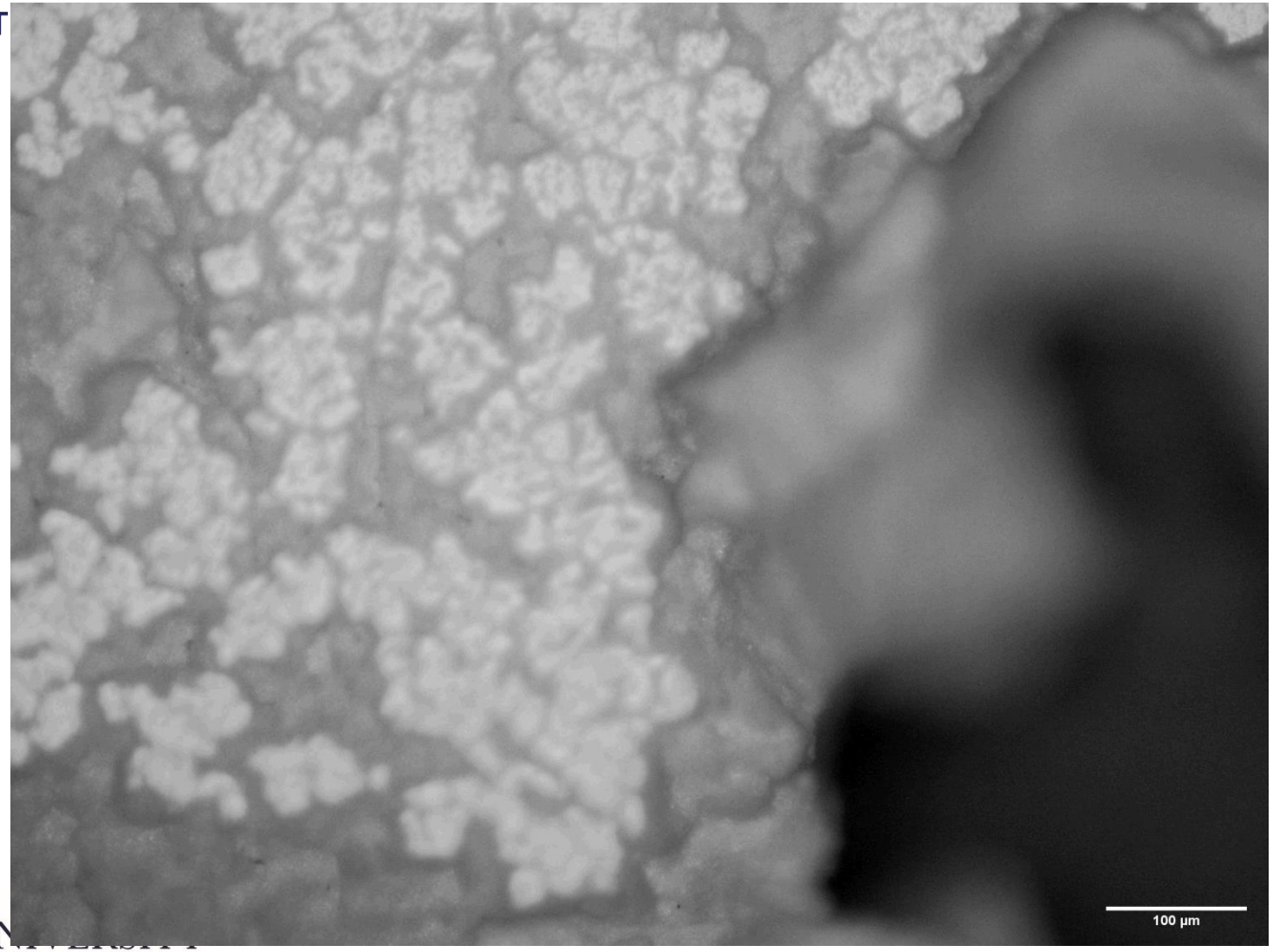

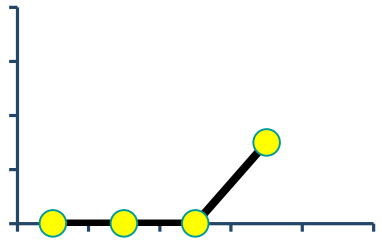

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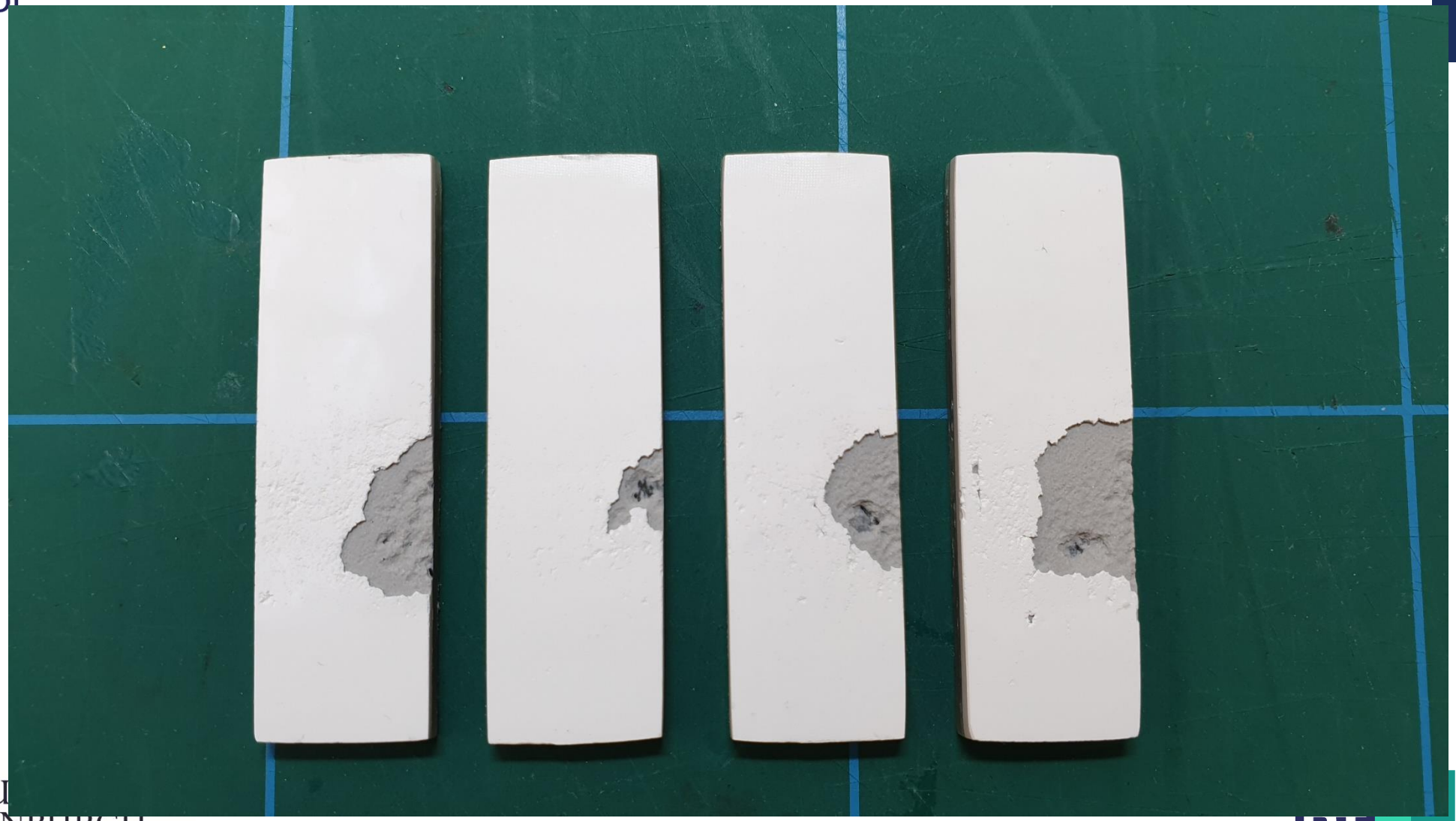

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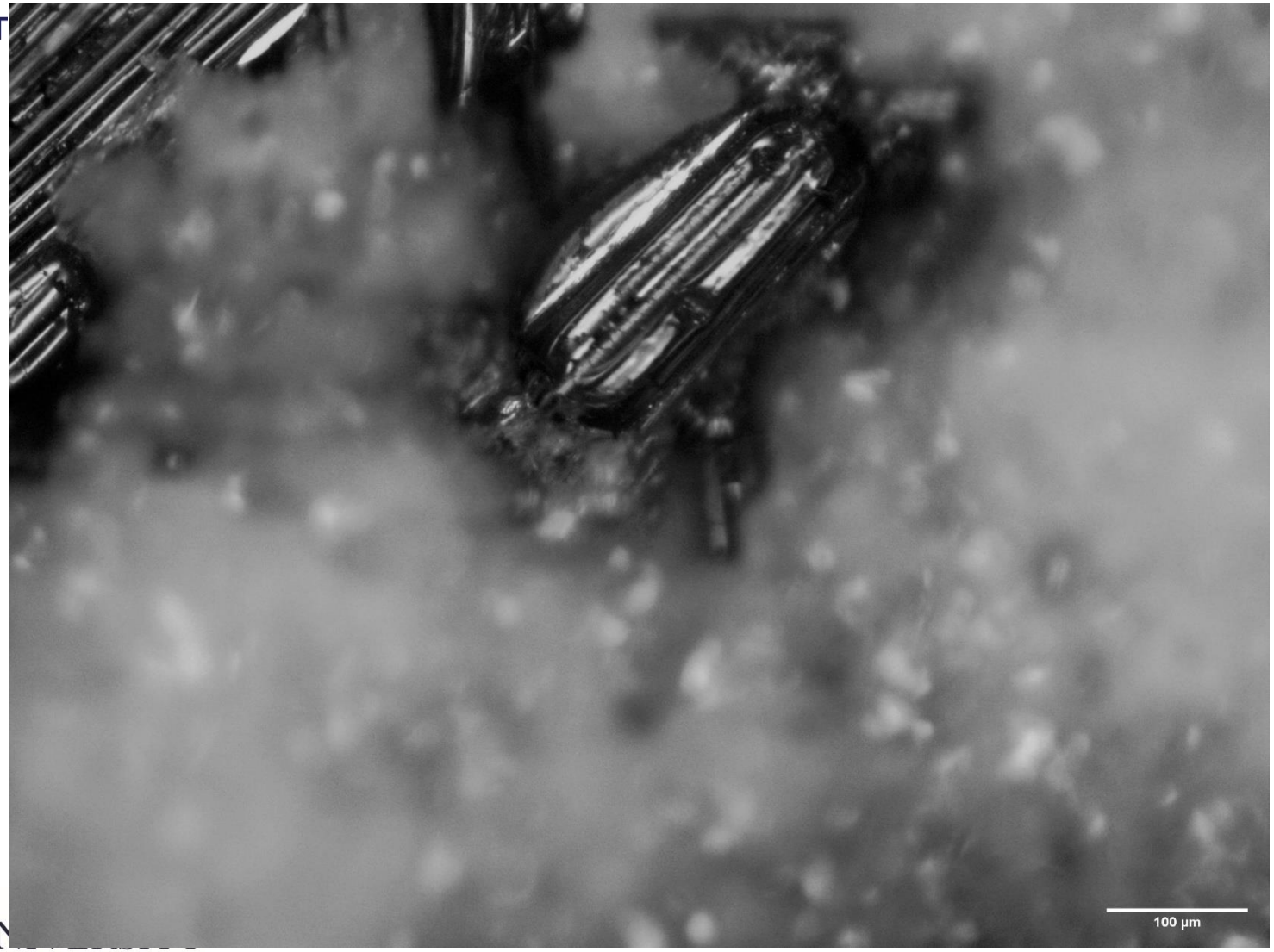
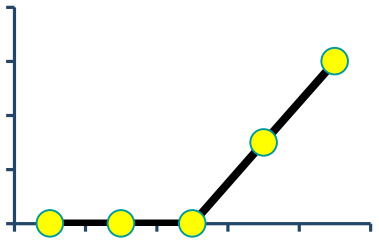
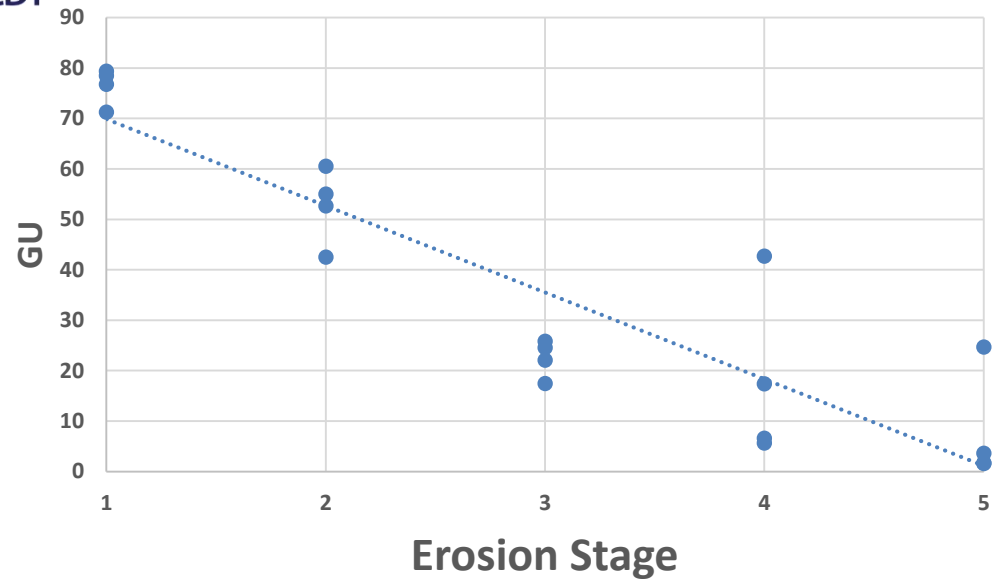
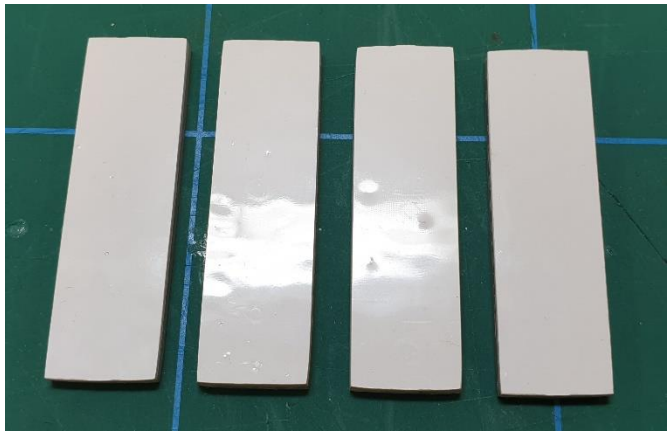
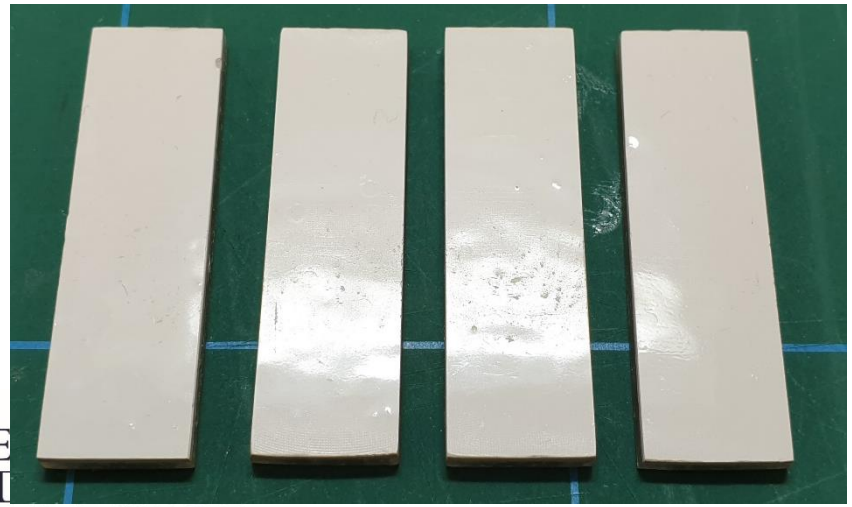


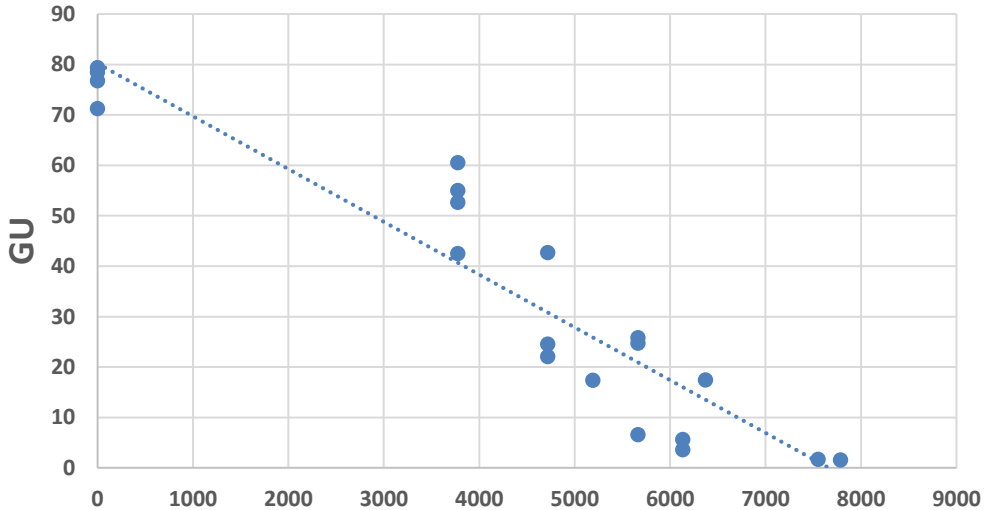


Gloss Measurement

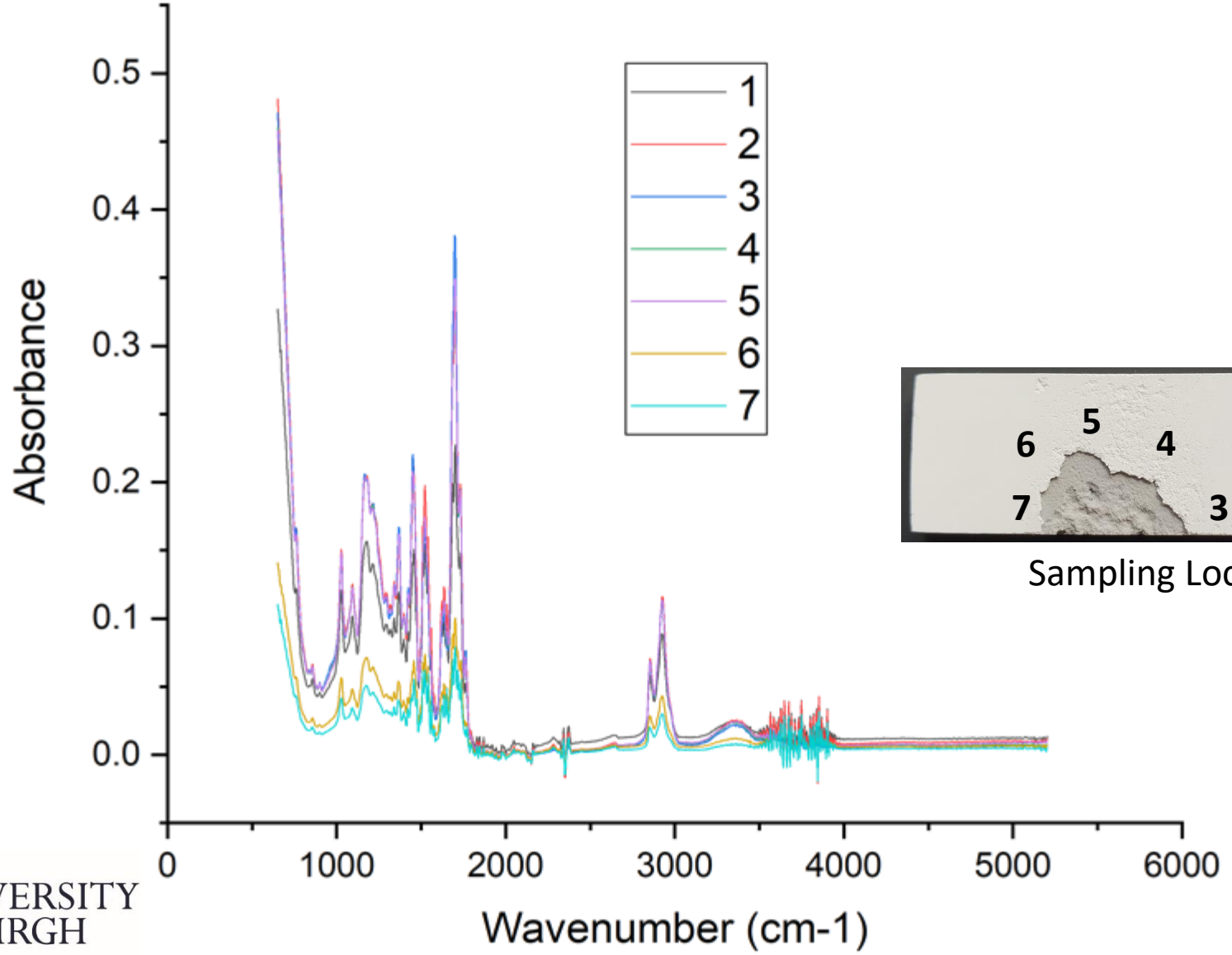






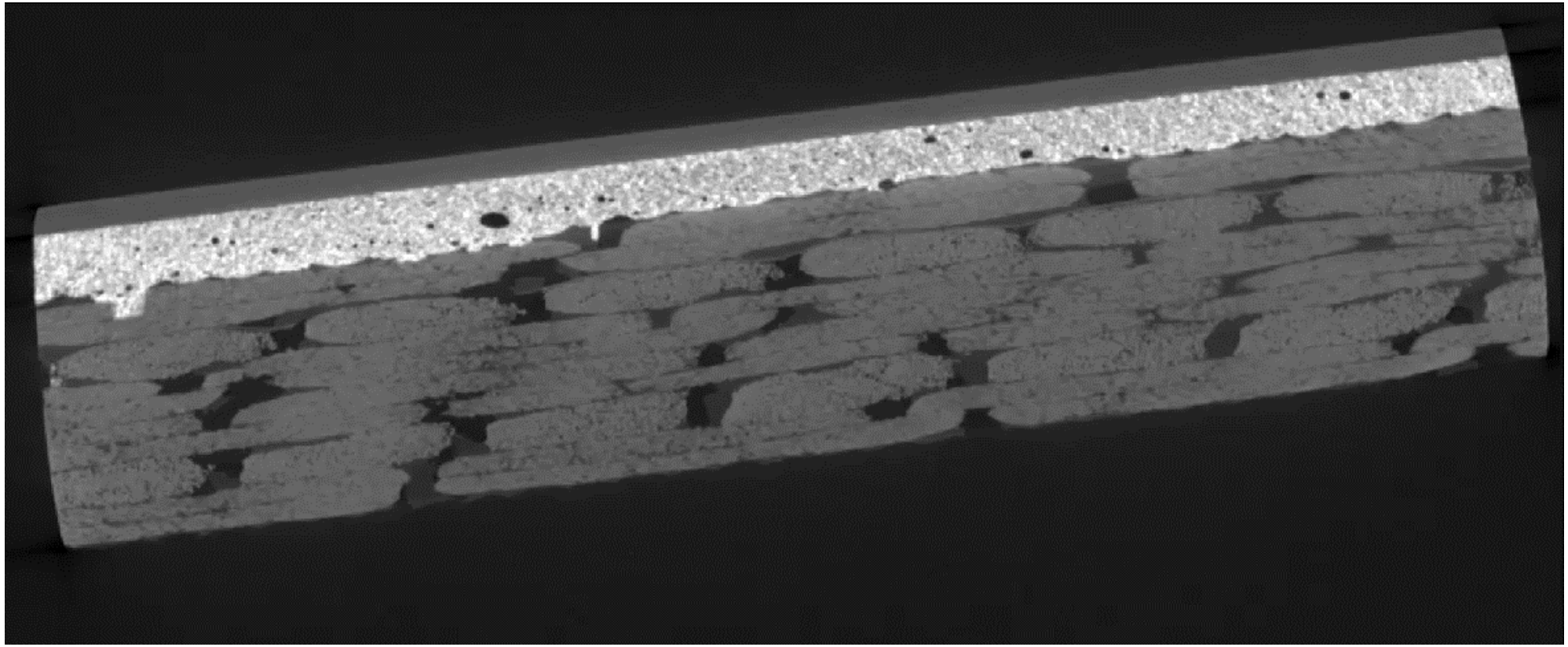


Spectroscopy (FTIR)



Sampling Locations

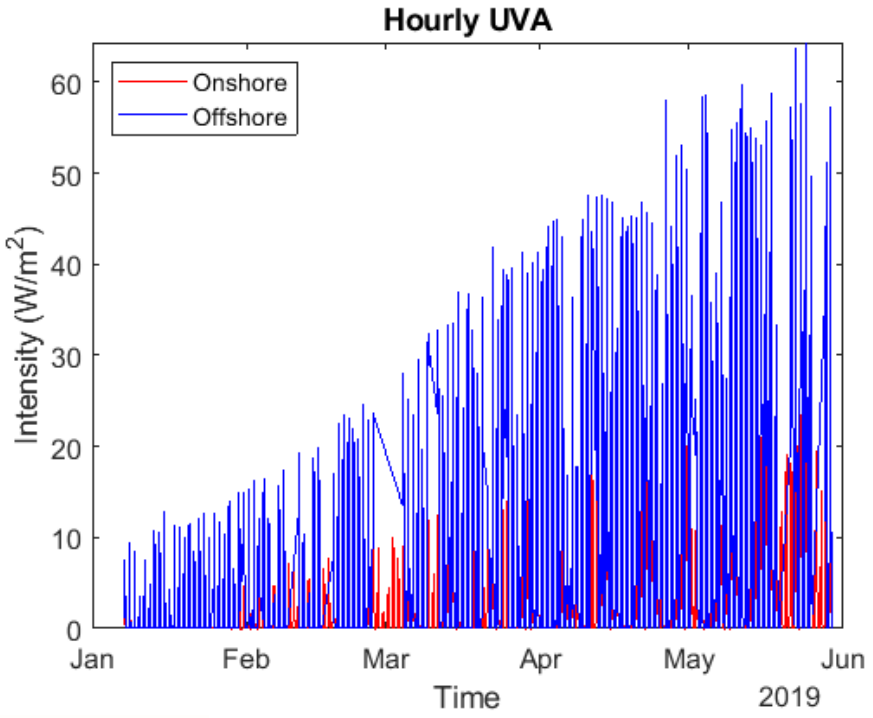
X-ray Imagery (XCT)

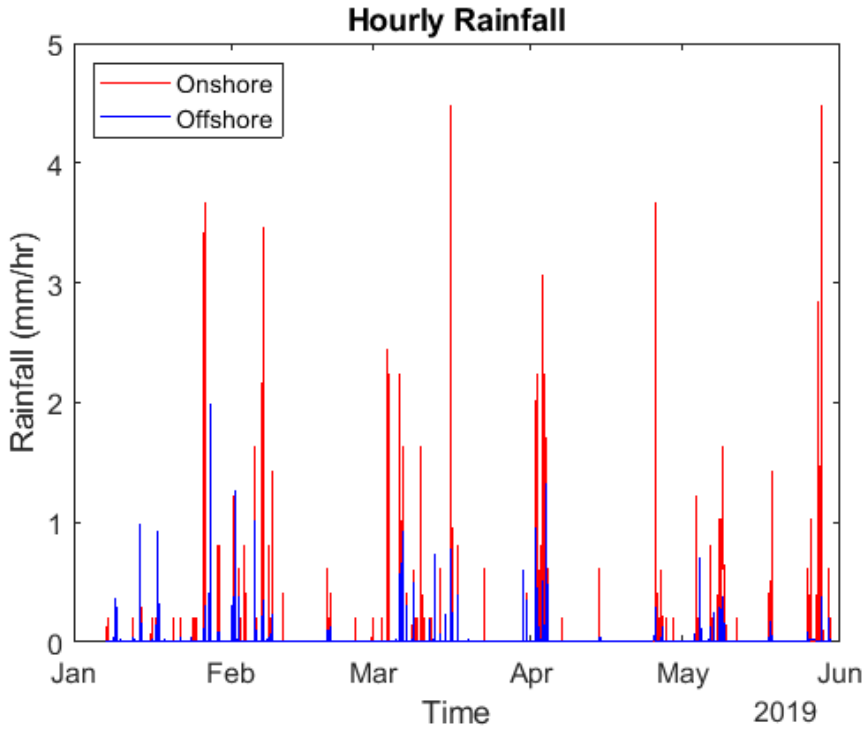


Weathering

Onshore & Offshore weathering data:

- UVA, UVB, Temp, Humidity, Rainfall
- Currently testing UVA & UVA + UVB on blade samples

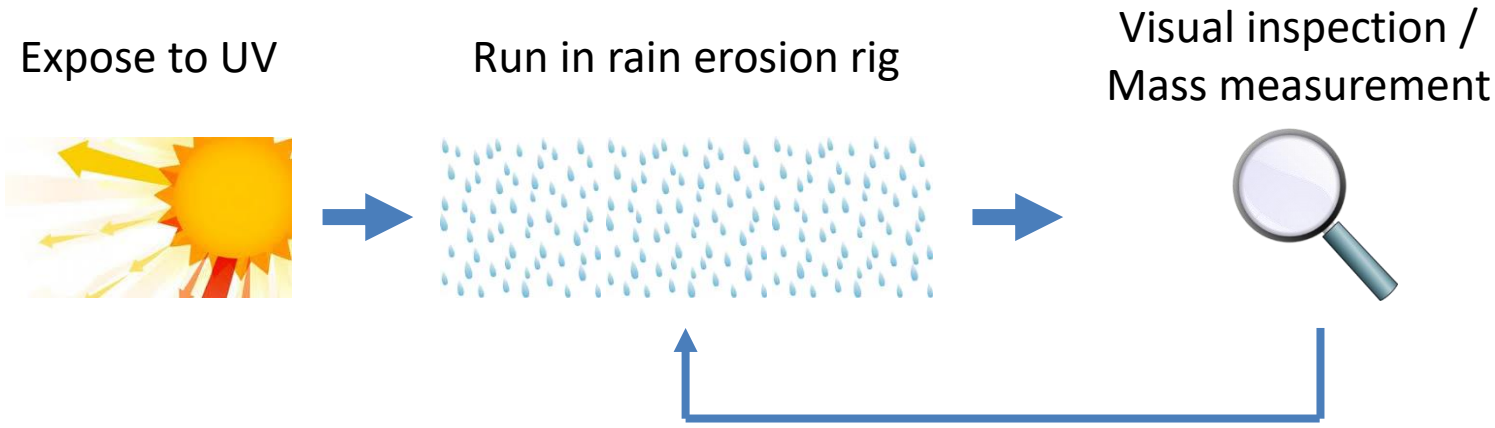




Current Wind Blade Coating Testing

Rain erosion & UV exposure are currently two separate processes - is this realistic?

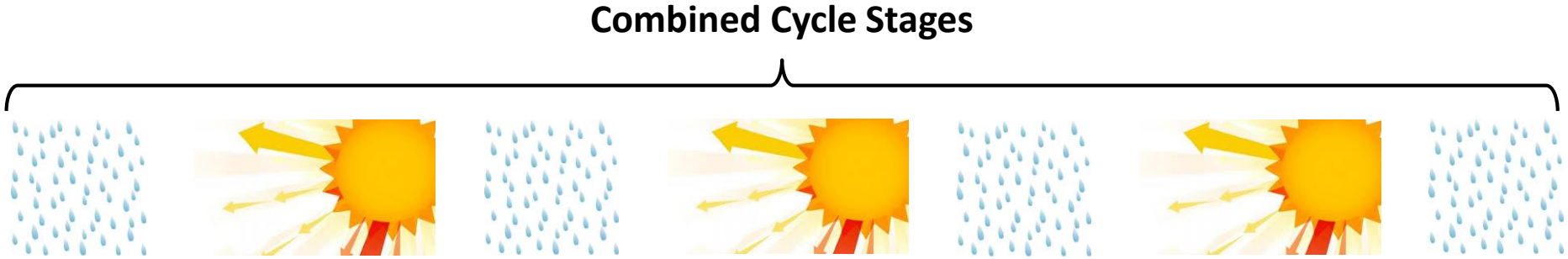
BS ISO/TS 19392 (2018):



Combined Cycle Weathering

Create multi-stage approach with both rain and weathering.

—Use data from offshore met mast to validate



PhD Overview

- Investigation into erosion/degradation mechanisms of wind blade coatings due to:
  - Rain, Weathering & Combined Rain and Weathering.
- So Far:
  - Results for rain. Currently in weathering campaign. Combined cycle to follow.
- Novelty:
  - New method of quantifying erosion
  - Show the importance of weathering

Thanks for your attention, any questions?


futureWind
2020
&
Marine