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EVALUATION OF COATINGS FOR REFRIGERATED SHIPPING CONTAINERS

Customer Authorization: Purchase Order

Report To: Institute of International Container Lessors
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1.0 INTRODUCTION

Six lots of six different paint system coupons, 36 in total, were submitted by the Institute of International Container Lessors for evaluation. A summary of the sample identifications and test matrix is shown in Table 1. The purpose of the evaluation was to analyze the coated samples after being subjected to mechanical and salt spray testing and to determine the corrosion performance after 500 hours of exposure to salt spray. The six coating systems were:

A. KCC: WB[1] Zinc rich primer + WB epoxy primer + WB acrylic top coat
B. KCC: Metalizing + WB epoxy primer + WB acrylic top coat
C. KCC: Metalizing + SB[2] epoxy primer + SB epoxy top coat
D. Kansai: WB zinc rich epoxy + WB epoxy primer + WB acrylic top coat
E. Kansai: Metalizing + WB epoxy primer + WB acrylic top coat
F. Kansai: Metalizing + SB epoxy primer + SB acrylic top coat

The samples were evaluated by the following laboratory procedures:

1) Impact Test
2) Bend Test
3) Salt Spray Test per ASTM B117[3]
4) Scribe Test per ASTM D1654[4]
5) Adhesion Test per ASTM D3359-09[5]

1.1 Summary

The results of this evaluation determined that after mechanical and salt spray testing the samples performed from best to worst in descending order as follows:

[1] WB - waterborne
[2] SB – solvent borne
[3] ASTM B 117 – *Standard Practice for Operating Salt Spray (Fog) Apparatus*
[4] ASTM D D1654 – *Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments*
[5] ASTM D 3359 – *Standard Test Method for Measuring Adhesion by Tape Test*

- Kansai: Metalizing + WB epoxy primer + WB acrylic top coat (E samples)
- Kansai: Metalizing + SB epoxy primer + SB acrylic top coat (F samples)
- KCC: Metalizing + SB epoxy primer + SB epoxy top coat (C samples)
- KCC: Metalizing + WB epoxy primer + WB acrylic top coat (B samples)
- KCC: WB zinc rich primer + WB epoxy primer + WB acrylic top coat (A samples)
- Kansai: WB zinc rich epoxy + WB epoxy primer + WB acrylic top coat (D samples)

2.0 EVALUATION

2.1 Visual Examination

Six lots with six samples of painted coupons were received for evaluation. Photographs of lots A – F, samples 1 – 6 are shown in the as-received condition in Figure 1 – Figure 6. Keyence digital images of the surface condition of the samples are shown in Figure 7 – Figure 8.

2.2 Impact Test

Samples A-1, B-1, C-1, D-1, E-1, and F-1 were impact tested, then salt spray tested per ASTM B117. The samples were placed coating side up on a support base at the bottom of a vertical ten-foot long guide tube and a 17-pound weight was dropped through the guide tube. Digital images of the surface condition of all samples after the impact test, before the salt spray test are shown in Figure 9 – Figure 14 and after the salt spray test are shown in Figure 21 – Figure 26. The results before salt spray are summarized in Table 2. All samples exhibited either some de-bonding of the coating at the impact point or cracks in the coating on the indentation slope, Sample B-1 and C-1 exhibited both debonding and cracking. The results following 500 hours of salt spray are shown in Table 4. The following is the ranking for performance in the impact test after 500 hours of salt spray:

- Kansai: Metalizing + SB epoxy primer + SB acrylic top coat (F samples)
- Kansai: Metalizing + WB epoxy primer + WB acrylic top coat (E samples)
- KCC: WB zinc rich primer + WB epoxy primer + WB acrylic top coat (A samples)
- KCC: Metalizing + SB epoxy primer + SB epoxy top coat (C samples)
- KCC: Metalizing + WB epoxy primer + WB acrylic top coat (B samples)
- Kansai: WB zinc rich epoxy + WB epoxy primer + WB acrylic top coat (D samples)

2.3 Bend Test

Samples A-2, B-2, C-2, D-2, E-2, and F-2 were bent to approximately 90 degrees using a three-point bend apparatus, then salt spray tested per ASTM B117 for 500 hours. The coupons were placed coating-side down for the bend test. Digital images of the surface condition of samples after the bend test, before the salt spray test are shown in Figure 15 – Figure 20 and after the salt spray test are shown in Figure 27 – Figure 32. The results prior to salt spray are summarized in

Table 3. All samples had cracking in the bend radius. The results after 500 hours of salt spray are presented in Table 4. The following is the ranking for performance in the bend test after 500 hours of salt spray exposure:

- Kansai: Metalizing + WB epoxy primer + WB acrylic top coat (E samples)
- Kansai: Metalizing + SB epoxy primer + SB acrylic top coat (F samples)
- KCC: Metalizing + WB epoxy primer + WB acrylic top coat (B samples)
- KCC: Metalizing + SB epoxy primer + SB epoxy top coat (C samples)
- Kansai: WB zinc rich epoxy + WB epoxy primer + WB acrylic top coat (D samples)
- KCC: WB zinc rich primer + WB epoxy primer + WB acrylic top coat (A samples)

2.4 ASTM B117 – Salt Spray Test

All samples (impact, bend, scribe and adhesion) were exposed to salt spray testing per ASTM B117 for a total of 500 hours. The degree of blistering was analyzed after 168 hours, 336 hours, and 500 hours of salt spray exposure per ASTM D714.[6] The results are summarized in Table 4. The number value refers to the blister size and ranges from 10 to 0, where a rating of 10 represents no blistering. The frequency of blistering is designated as: dense (D), medium dense (MD), medium (M), and few (F).

The degree of rusting was analyzed after 168 hours, 336 hours, and 500 hours of salt spray exposure per ASTM D610.[7] The results are summarized in Table 4. The number value refers to the percentage of the total surface area being rusted and ranges from 0 to 10, where a rating of 10 represents no rusting and a rating of 0 represents 50% and greater of the total surface area being rusted.

The impact test samples A-1, C-1, E-1, and F-1 exhibited excellent results scoring 10 for red rust (ASTM D 610) and 10 for blister (ASTM D 714). Sample B-1 had a slightly lower performance with a score of 9 for red rust (ASTM D 610) and 10 for blister (ASTM D 714). Sample D-1 had the poorest impact performance, scoring 8 red rust (ASTM D 610) and 4 Few for blister (ASTM D 714).

Bend test samples E-2 and F-2 had the best performance after 500 hours of salt spray scoring 9 red rust (ASTM D 610) and 10 for blister (ASTM D 714). Sample C-2 exhibited a slightly lower performance with and 8 for red rust (ASTM D 610) and 10 for blister (ASTM D 714). Samples A-2 and D-2 had the poorest performance scoring 4 and 5, respectively, for red rust (ASTM D 610) and 10 for blister (ASTM D 714).

2.5 ASTM D1654 – Scribe Test

Samples A-3, B-3, C-3, D-3, E-3, and F-3 was scribed per ASTM D1654, then salt spray tested per ASTM B117 for 500 hours. The results are summarized in Table 4. Digital images of the

[6] ASTM D 714 - *Standard Test Method for Evaluating Degree of Blistering of Paints*
[7] ASTM D 610 – *Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces*

surface condition of the samples after the scribe and salt spray testing are shown in Figure 33 – Figure 38.

All samples performed well in the scribe test, sample C-3 had the highest overall rating of 9, all the other samples rated 8 overall. The rankings for the scribe test are as follows:

- Kansai: Metalizing + WB epoxy primer + WB acrylic top coat (E samples)
- Kansai: Metalizing + SB epoxy primer + SB acrylic top coat (F samples)
- KCC: Metalizing + WB epoxy primer + WB acrylic top coat (B samples)
- KCC: Metalizing + SB epoxy primer + SB epoxy top coat (C samples)
- KCC: WB zinc rich primer + WB epoxy primer + WB acrylic top coat (A samples)
- Kansai: WB zinc rich epoxy + WB epoxy primer + WB acrylic top coat (D samples)

2.6 ASTM D3359 – Adhesion Test

Samples A-4, B-4, C-4, D-4, E-4, and F-4 was salt spray tested per ASTM B117, then tested for adhesion performance per ASTM D3359. The sample was exposed to a salt fog environment for 500 hours, then three adhesion tests were performed on the coating surface. Digital images of the surface condition of the samples after the adhesion test are shown in Figure 39 – Figure 44.

The results are summarized in Table 5. Three replicates were examined for each sample. The adhesion is rated on a scale from 5B to 0B, where 5B has completed smooth edges of the cuts and no coating detachment of the lattice while 0B has flaking and 65% or greater coating detachment of the lattice. All samples exhibited excellent adhesion performance, with 5B ratings.

3.0 DISCUSSION

All six of the paint systems performed well in the scribe and adhesion tests.

Overall, performance of the six paint systems after the combination of mechanical and 500 hours of salt spray testing are ranked from best to worst in descending order below:

- Kansai: Metalizing + WB epoxy primer + WB acrylic top coat (E samples)
- Kansai: Metalizing + SB epoxy primer + SB acrylic top coat (F samples)
- KCC: Metalizing + SB epoxy primer + SB epoxy top coat (C samples)
- KCC: Metalizing + WB epoxy primer + WB acrylic top coat (B samples)
- KCC: WB zinc rich primer + WB epoxy primer + WB acrylic top coat (A samples)
- Kansai: WB zinc rich epoxy + WB epoxy primer + WB acrylic top coat (D samples)

4.0 CONCLUSIONS[8,9]

The following conclusions are based upon the submitted samples and the evidence gathered:

1. Overall, the four metalized samples (B, C, E, F) performed better than the two non-metallized samples (A and D).
2. The overall performance of the six paint systems after the combination of mechanical and 500 hours of salt spray testing are ranked from best to worst in descending order below:
   - Kansai: Metalizing + WB epoxy primer + WB acrylic top coat (E samples)
   - Kansai: Metalizing + SB epoxy primer + SB acrylic top coat (F samples)
   - KCC: Metalizing + SB epoxy primer + SB epoxy top coat (C samples)
   - KCC: Metalizing + WB epoxy primer + WB acrylic top coat (B samples)
   - KCC: WB zinc rich primer + WB epoxy primer + WB acrylic top coat (A samples)
   - Kansai: WB zinc rich epoxy + WB epoxy primer + WB acrylic top coat (D samples)

Summary of Container Paint Tests and Rankings

Tests	Samples					
	A KCC WB ZRP + WB epoxy primer + WB acrylic top coat	**B** KCC Metalizing + WB epoxy primer + WB acrylic top coat	**C** KCC Metalizing + SB mid-coat + SB Epoxy top coat	**D** Kansai WB ZRP + WB epoxy primer + WB acrylic top coat	**E** Kansai Metalizing + WB epoxy primer + WB acrylic top coat	**F** Kansai Metalizing + SB epoxy primer + SB acrylic top coat
Impact*	1	5	1	6	1	1
Bend*	6	3	4	5	1	1
Scribe*	5	3	4	6	1	2
Adhesion*	1	1	1	1	1	1

* Rankings range from 1 to 6 where 1 is the best and 6 exhibited the poorest performance.

[8] The conclusions in this report are based upon the available information and evidence provided by the client and gathered by Anamet, within the scope of work authorized by the client, and they are hereby presented by Anamet to a reasonable degree of engineering and scientific certainty. Anamet reserves the right to amend or supplement its conclusions or opinions presented in this report should additional data or information become available, or further work be approved by the client.

[9] The client is responsible for specifying acceptance criteria, standards, codes, and procedures required for the submitted testing, if any. When a statement of conformity to a specification or standard is provided in an Anamet report, measurement uncertainty is not taken into account unless otherwise requested in writing by the client.

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Table 1 – Test Matrix

Manufacturer	Coating	Sample Identification	Testing Performed			
			Impact	Bend	Scribe	Adhesion
KCC	WB Zinc Rich Primer + WB Epoxy Primer + WB Acrylic Top Coat	A-1	X			
		A-2		X		
		A-3			X	
		A-4				X
		A-5				
		A-6				
KCC	Metalizing + WB Epoxy Primer + WB Acrylic Top Coat	B-1	X			
		B-2		X		
		B-3			X	
		B-4				X
		B-5				
		B-6				
KCC	Metalizing + SB Epoxy primer + SB Epoxy Top Coat	C-1	X			
		C-2		X		
		C-3			X	
		C-4				X
		C-5				
		C-6				
Kansai	WB Zinc Rich Epoxy + WB Epoxy Primer + WB Acrylic Top Coat	D-1	X			
		D-2		X		
		D-3			X	
		D-4				X
		D-5				
		D-6				
Kansai	Metalizing + WB Epoxy Primer + WB Acrylic Top Coat	E-1	X			
		E-2		X		
		E-3			X	
		E-4				X
		E-5				
		E-6				
Kansai	Metalizing + SB Epoxy Primer + SB Acrylic Top Coat	F-1	X			
		F-2		X		
		F-3			X	
		F-4				X
		F-5				
		F-6				

Table 2 – Results of Impact Test

Sample Identification	Coating De-Bonded from Substrate Indentation Base	Coating Cracked on Indentation Slope
A-1	Yes	No
B-1	Yes	Yes
C-1	No	Yes
D-1	Yes	Yes
E-1	No	Yes
F-1	Yes	No

Table 3 – Results of Bend Test

Sample Identification	Coating Cracked on Bend Radius
A-2	Yes
B-2	Yes
C-2	Yes
D-2	Yes
E-2	Yes
F-2	Yes

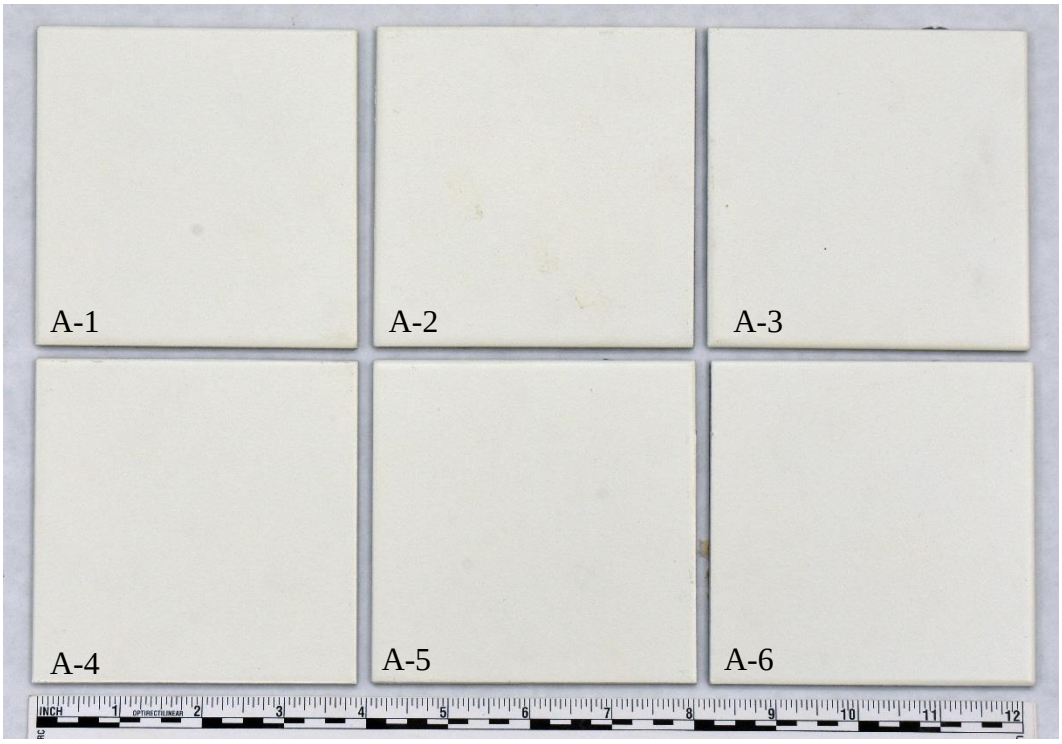
Table 4
Results of Evaluation Based on ASTM D714 and D1654 after 500 Hours of Salt Spray Exposure

		Salt Spray after 168 hours		Salt Spray after 336 hours		Salt Spray after 500 hours		
Sample Identification	Test	ASTM D610 Red Rust	ASTM D714 Blister	ASTM D610 Red Rust	ASTM D714 Blister	ASTM D610 Red Rust	ASTM D714 Blister	ASTM D1654 Scribe
A-1	Impact	10	10	10	10	10	10	
A-2	Bend	7	10	5	10	4	10	
A-3	Scribe	10	10	10	6 Few	9	6 Few	8
A-4	Adhesion	10	10	10	10	10	10	
B-1	Impact	10	10	10	10	9	10	
B-2	Bend	9	10	9	6 Few	9	6 Few	
B-3	Scribe	10	10	9	4 Few	9	4 Few	8
B-4	Adhesion	10	10	10	10	9	10	
C-1	Impact	10	10	10	10	10	10	
C-2	Bend	9	10	9	10	8	10	
C-3	Scribe	10	10	10	6 Few	10	6 Few	9
C-4	Adhesion	10	10	10	6 Few	9	4 Few	
D-1	Impact	10	10	10	10	8	4 Few	
D-2	Bend	7	10	5	10	5	10	
D-3	Scribe	10	10	9	6 Few	9	6 Few	8
D-4	Adhesion	10	10	10	10	10	10	
E-1	Impact	10	10	10	10	10	10	
E-2	Bend	9	10	9	10	9	10	
E-3	Scribe	10	10	9	4 Few	9	4 Few	8
E-4	Adhesion	10	10	10	10	9	10	
F-1	Impact	10	10	10	10	10	10	
F-2	Bend	9	10	9	10	9	10	
F-3	Scribe	10	10	10	4 Few	10	4 Few	8
F-4	Adhesion	10	10	9	4 Few	9	4 Few	

Table 5
Results of Adhesion Test After 500 Hours Salt Spray Exposure
Evaluation Based on ASTM D 3359-09, Method B

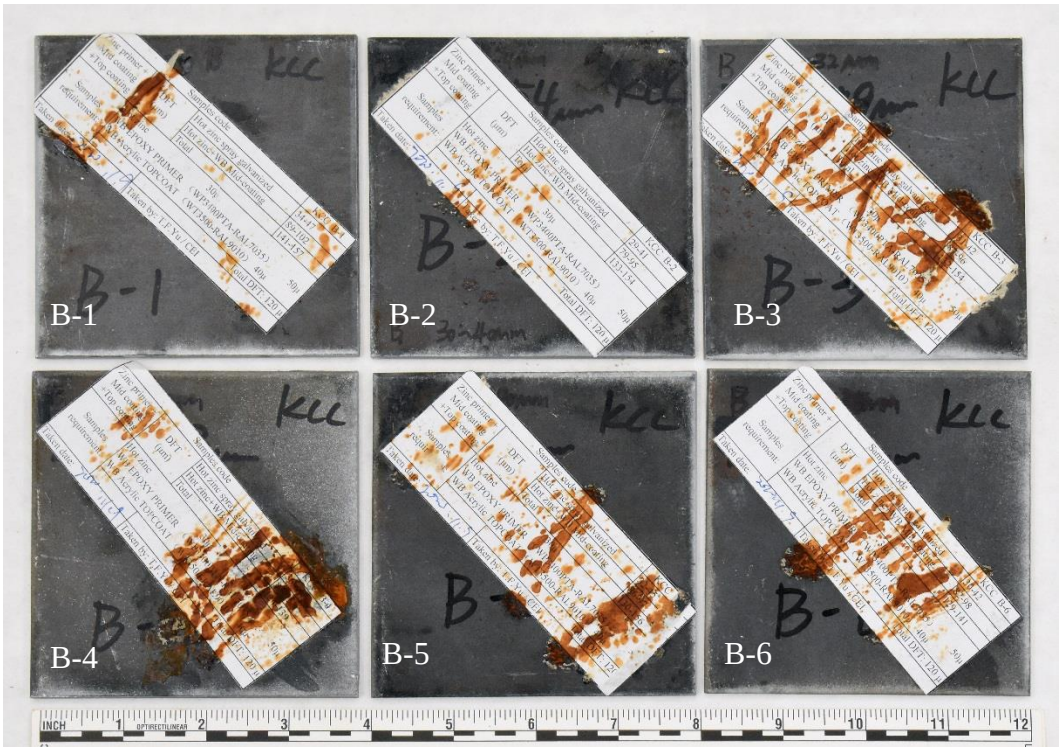
Sample Identification	Replicate	Adhesion per ASTM D 3359-09, Method B
A-4	T1 T2 T3	5B 5B 5B
B-4	T1 T2 T3	5B 5B 5B
C-4	T1 T2 T3	5B 5B 5B
D-4	T1 T2 T3	5B 5B 5B
E-4	T1 T2 T3	5B 5B 5B
F-4	T1 T2 T3	5B 5B 5B

(a) Samples A1 – A6, Label Side

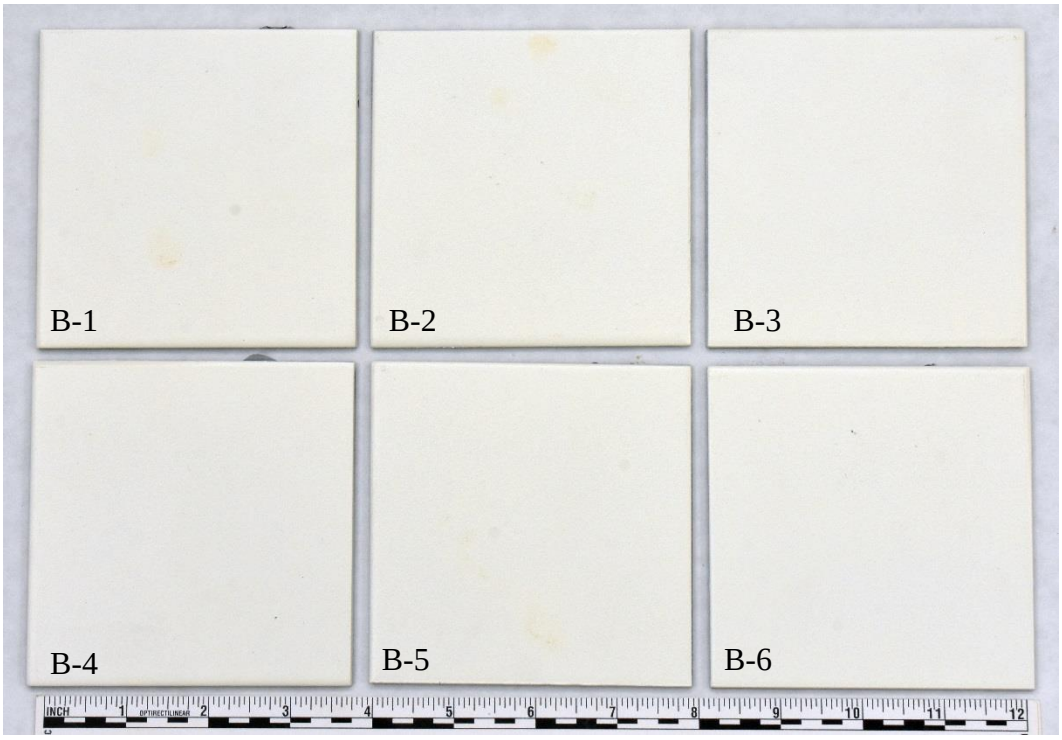


(b) Samples A1 – A6, Paint Side

Figure 1 Photographs of Samples A1 – A6 (a) label side and (b) paint side.



(a) Samples B1 – B6, Label Side



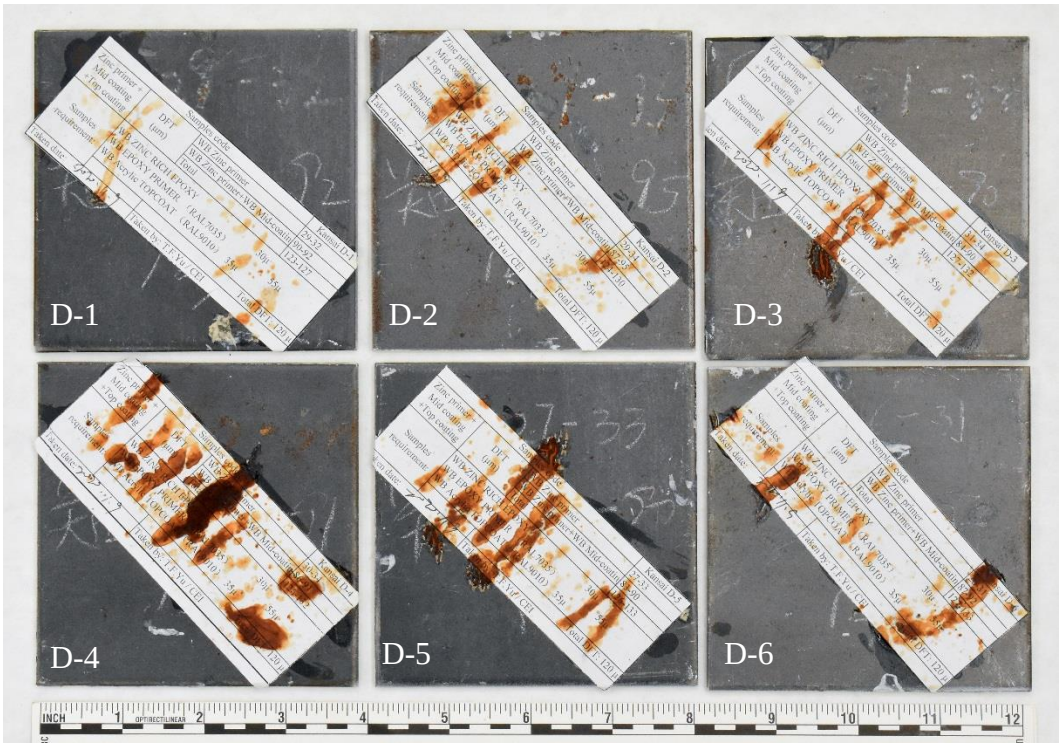
(b) Samples B1 – B6, Paint Side

Figure 2 Photographs of Samples B1 – B6 (a) label side and (b) paint side.

(a) Samples C1 – C6, Label Side

(b) Samples C1 – C6, Paint Side

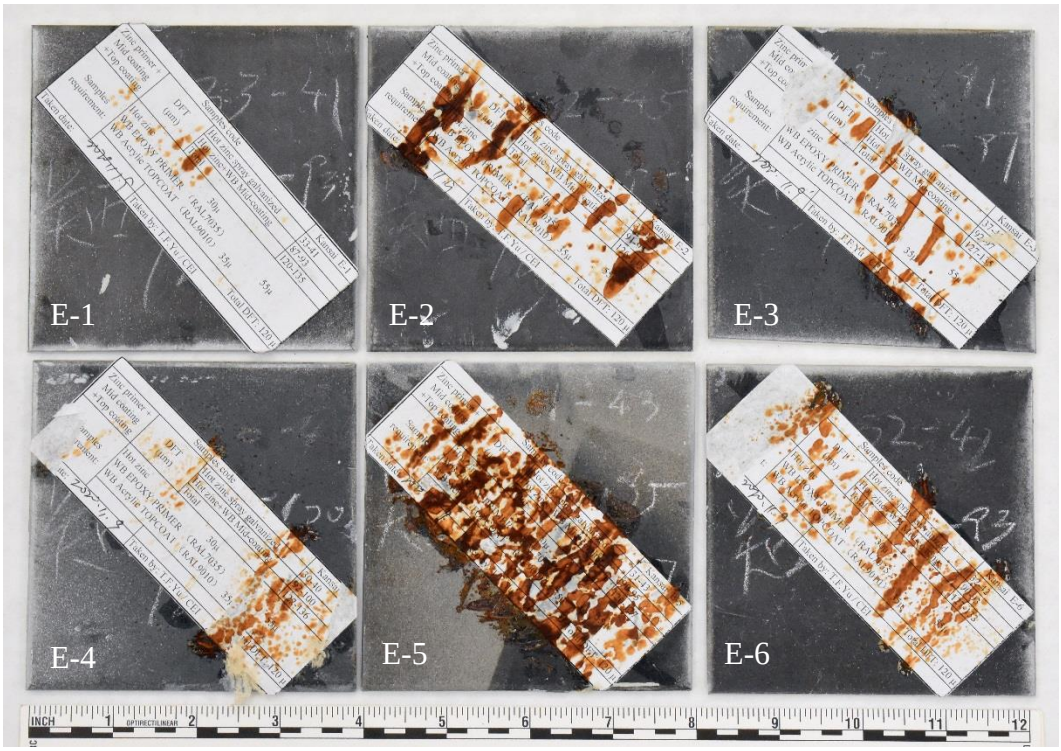
Figure 3 Photographs of Samples C1 – C6 (a) label side and (b) paint side.



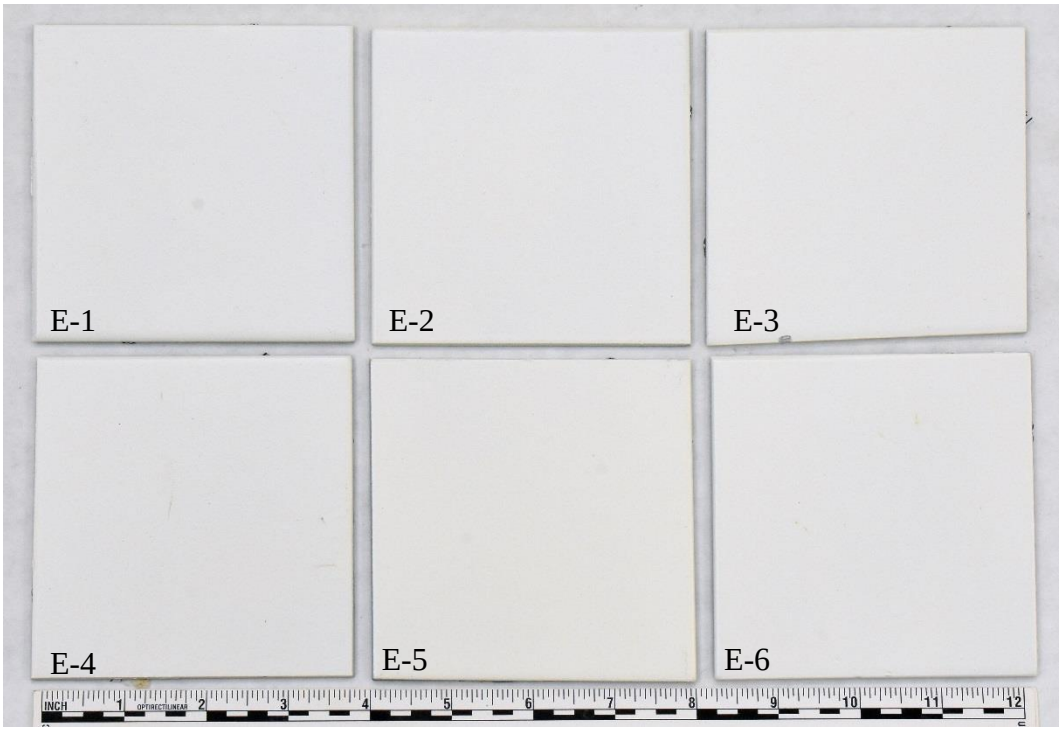
(a) Samples D1 – D6, Label Side

(b) Samples D1 – D6, Paint Side

Figure 4 Photographs of Samples D1 – D6 (a) label side and (b) paint side.



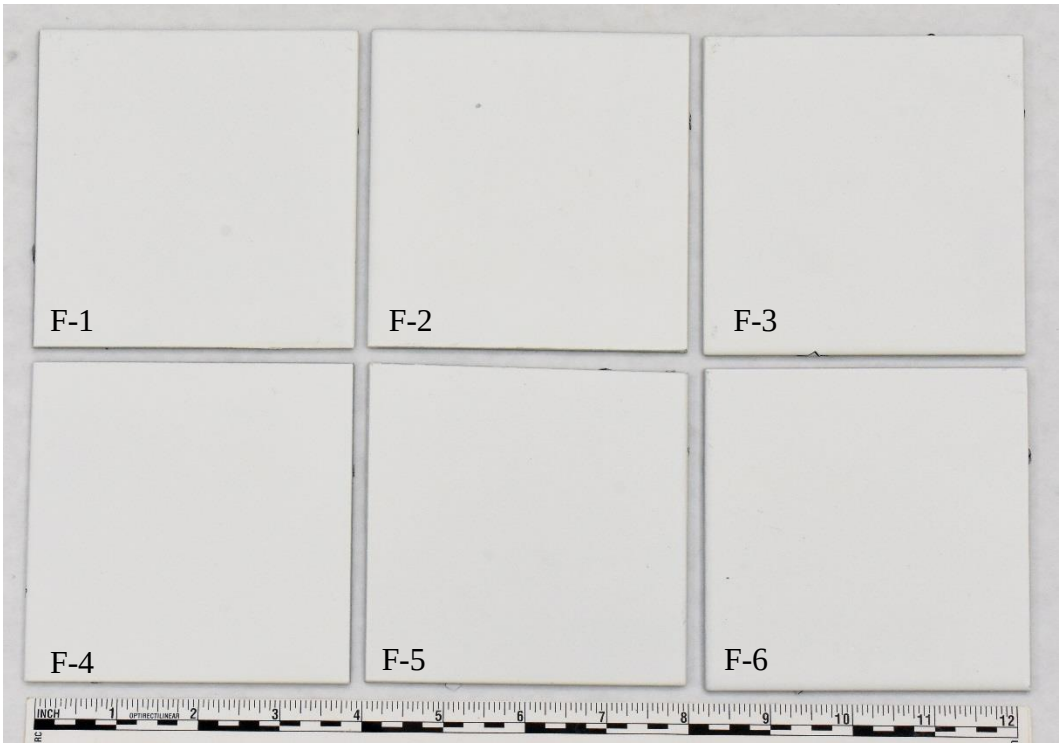
(a) Samples E1 – E6, Label Side



(b) Samples E1 – E6, Paint Side

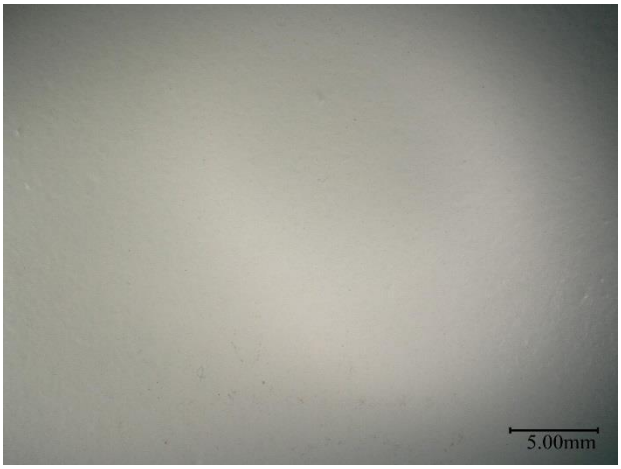
Figure 5 Photographs of Samples E1 – E6 (a) label side and (b) paint side.

(a) Samples C1 – C6, Label Side

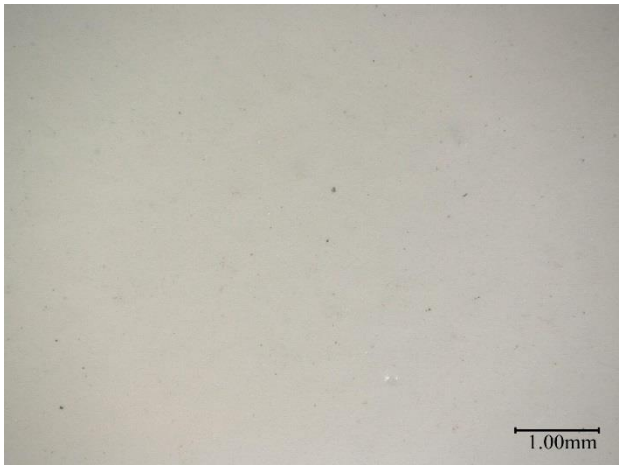


(b) Samples F1 – F6, Paint Side

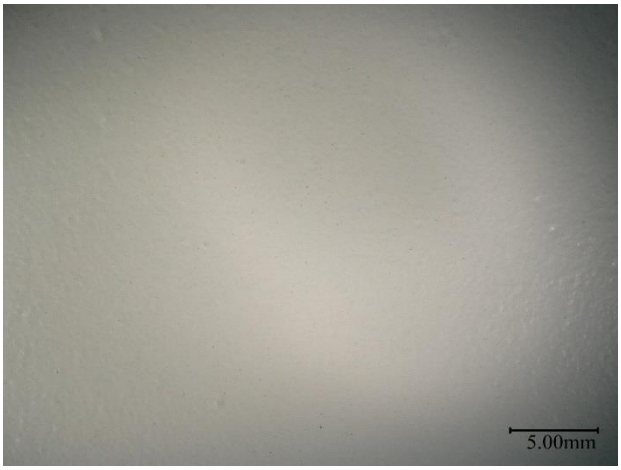
Figure 6 Photographs of Samples F1 – F6 (a) label side and (b) paint side.



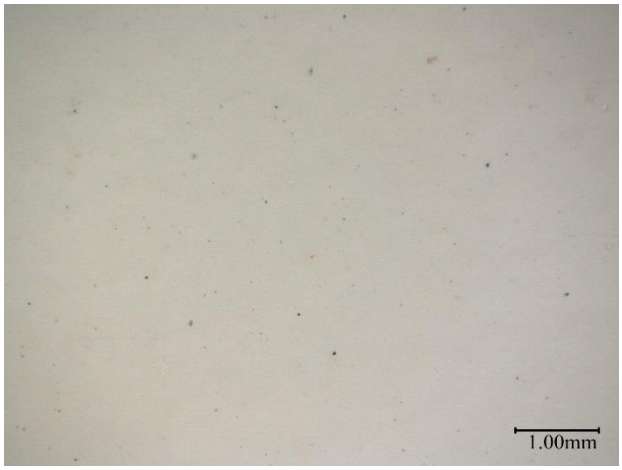
(a) Sample A-1 10X



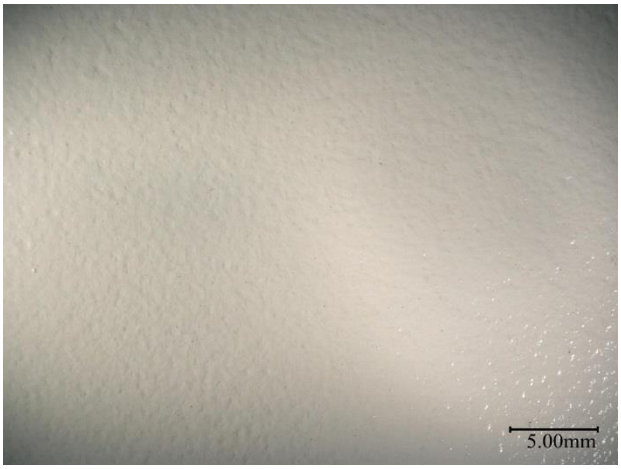
(b) Sample A-1 50X



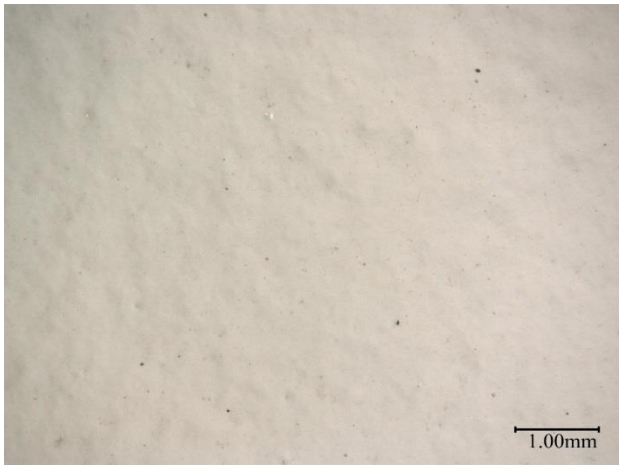
(c) Sample B-1 10X



(d) Sample B-1 50X

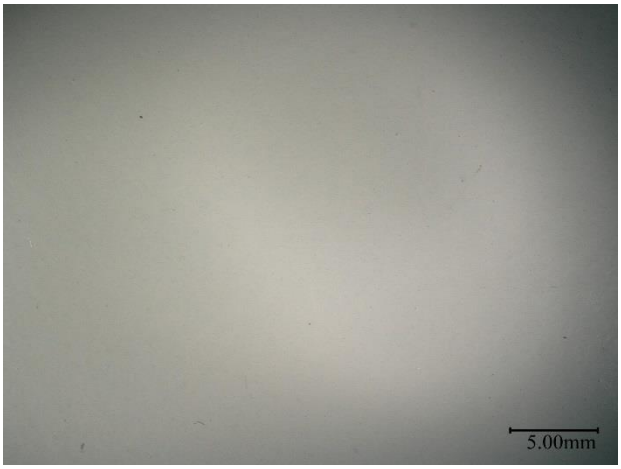


(e) Sample C-1 10X

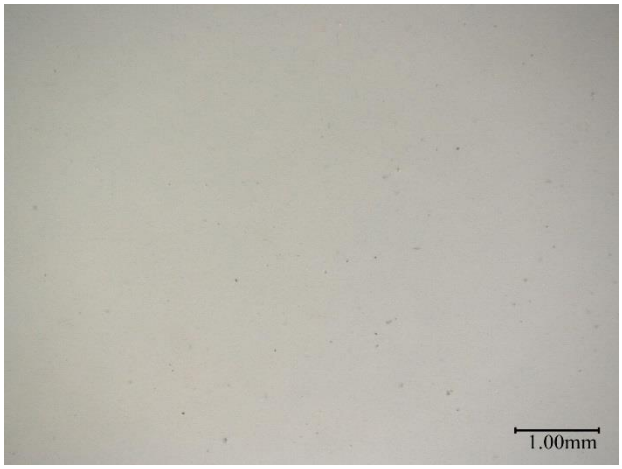


(f) Sample C-1 50X

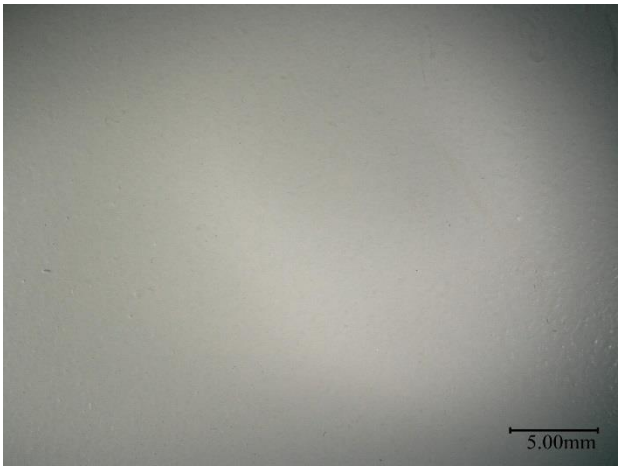
Figure 7 Digital microscope images of the coupon surface of (a – b) Sample A-1, (c – d) Sample B-1, and (e – f) Sample C-1.



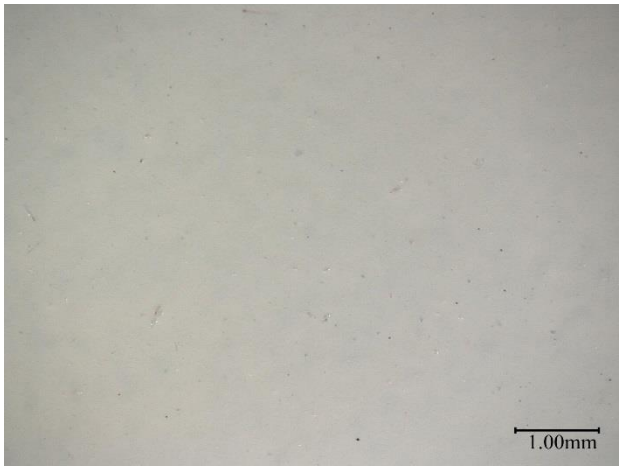
(a) Sample D-1 10X



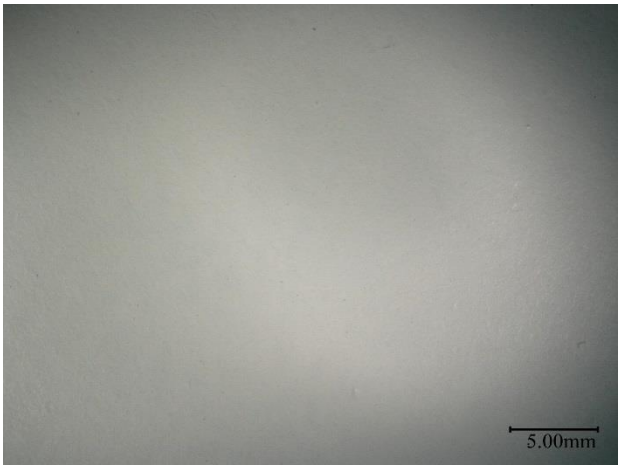
(b) Sample D-1 50X



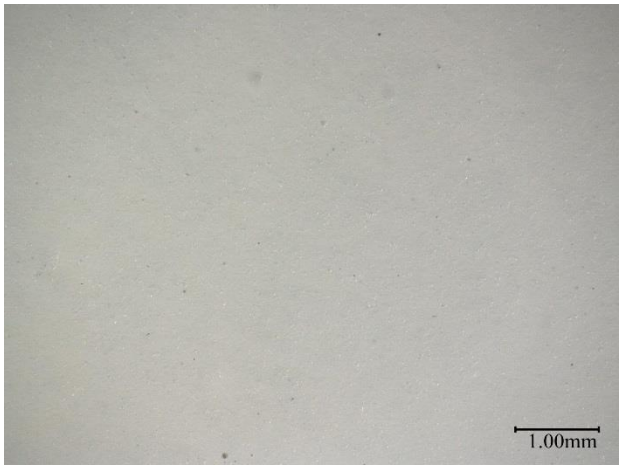
(c) Sample E-1 10X



(d) Sample E-1 50X

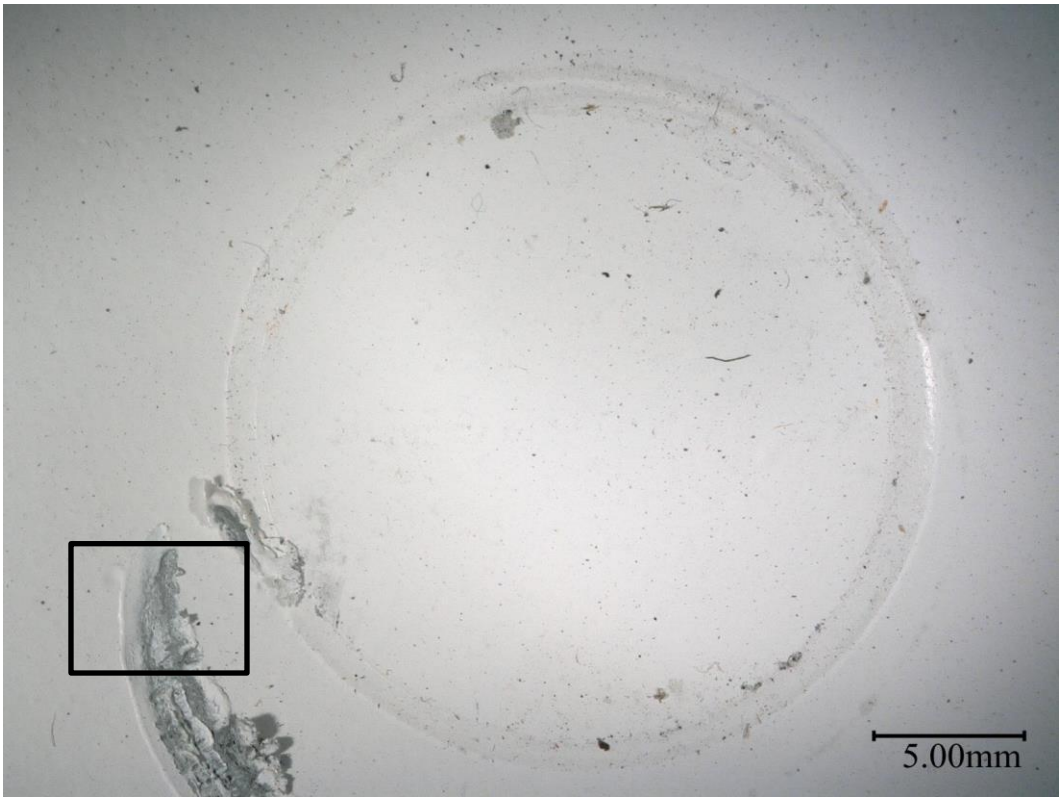


(e) Sample F-1 10X

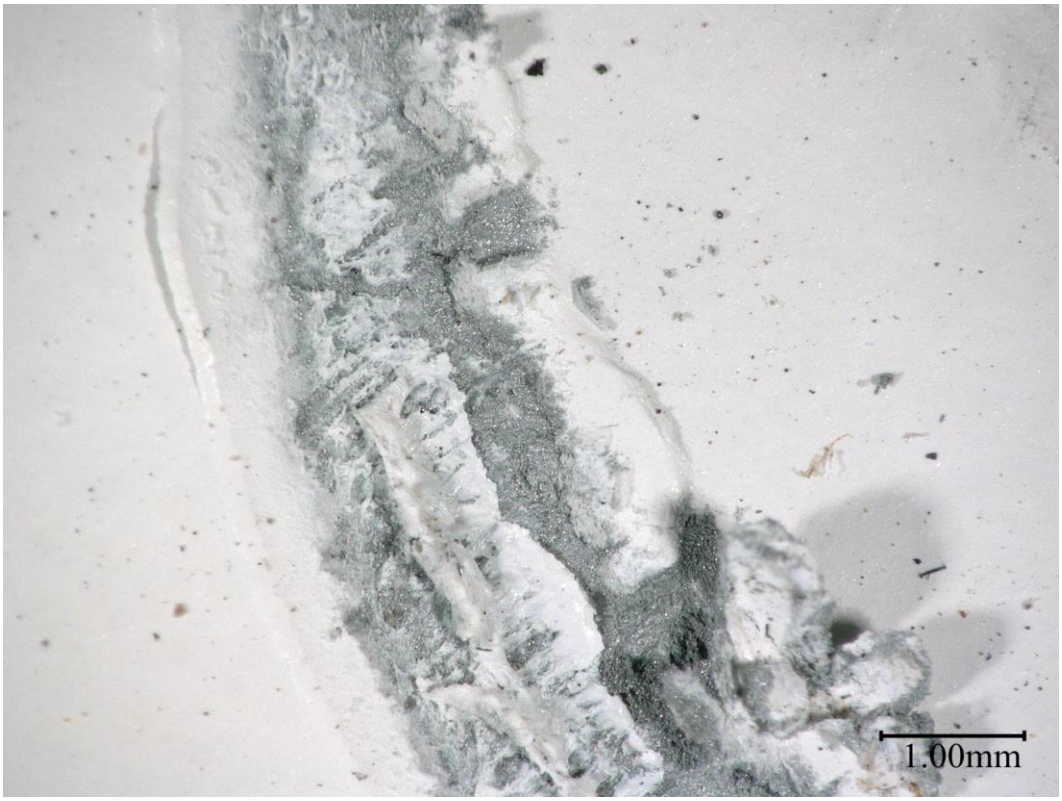


(f) Sample F-1 50X

Figure 8 Digital microscope images of the coupon surface of (a – b) Sample D-1, (c – d) Sample E-1, and (e – f) Sample F-1.

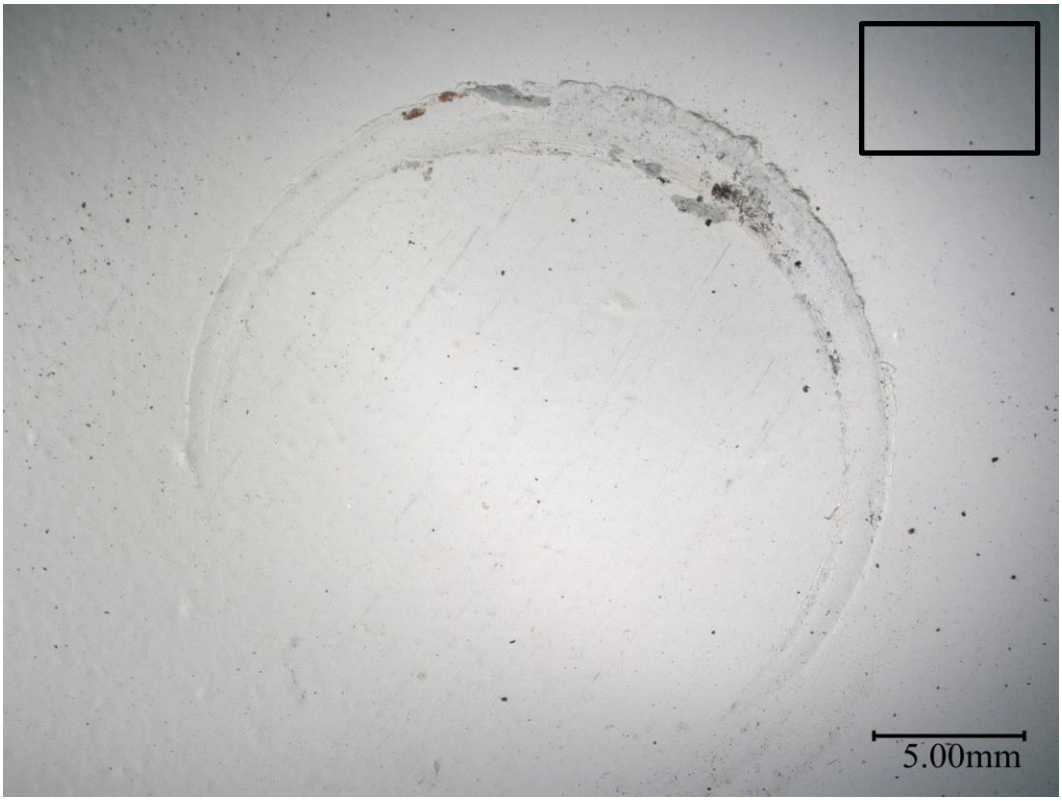


(a) Sample A-1 10X

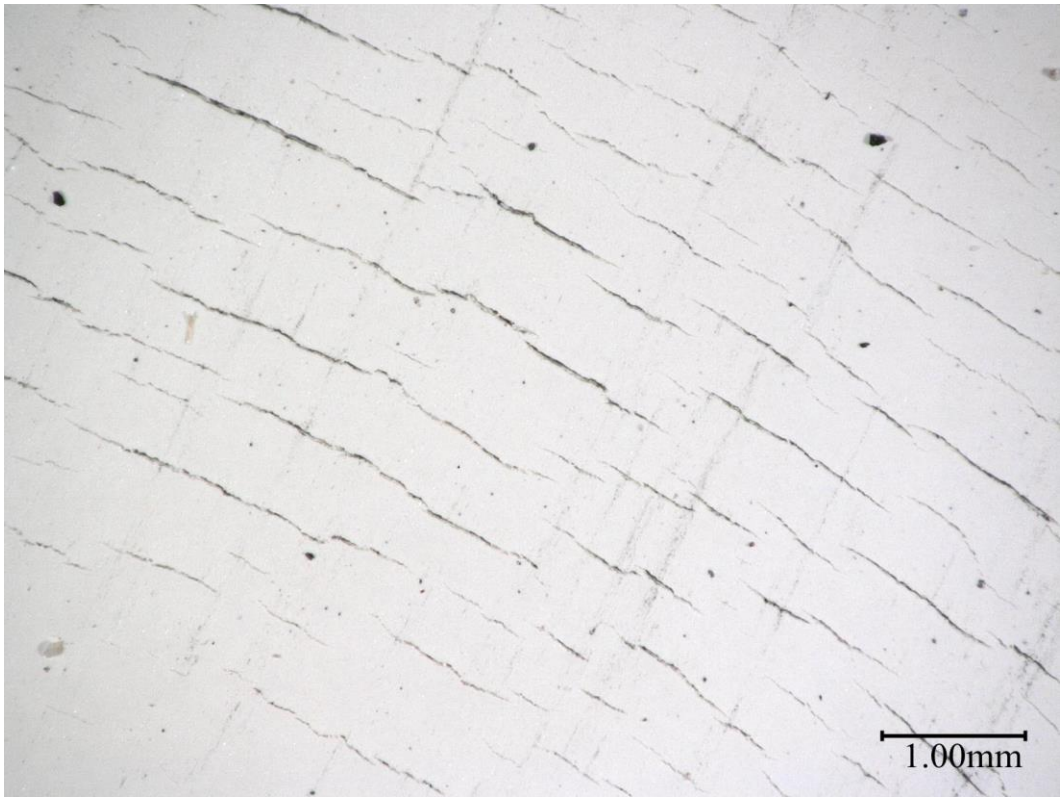


(b) Sample A-1, Box in (a) 50X

Figure 9 Digital microscope images of Sample A-1 after an impact test.

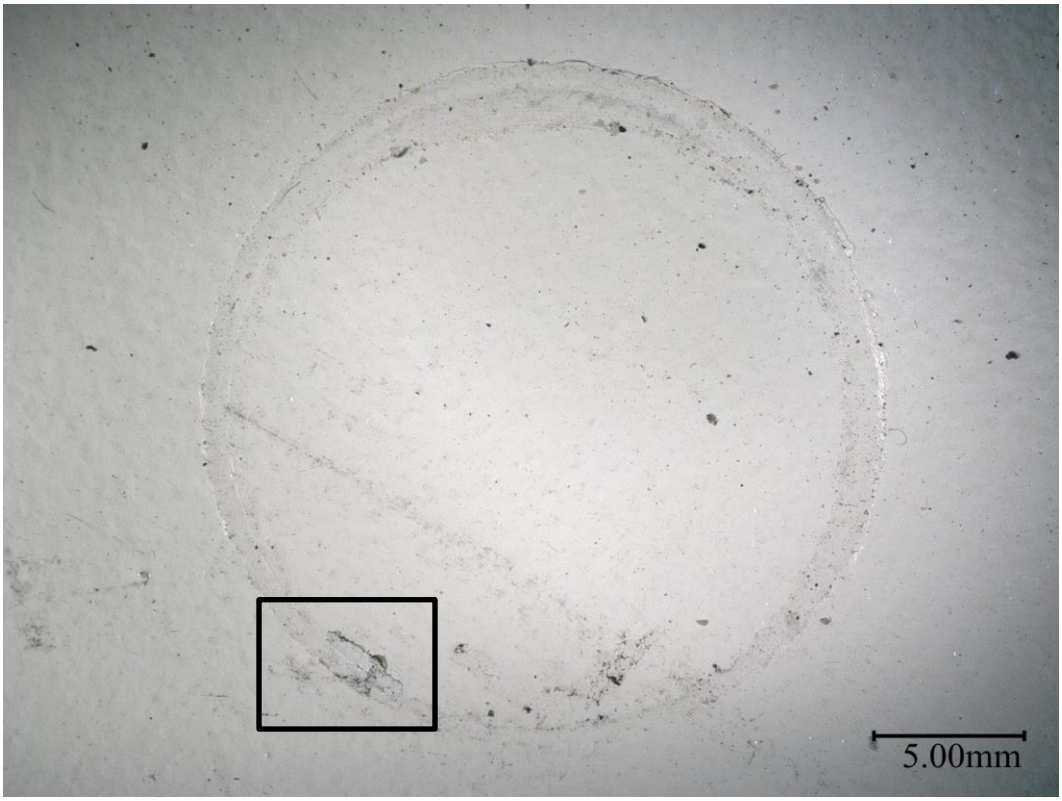


(a) Sample B-1 10X

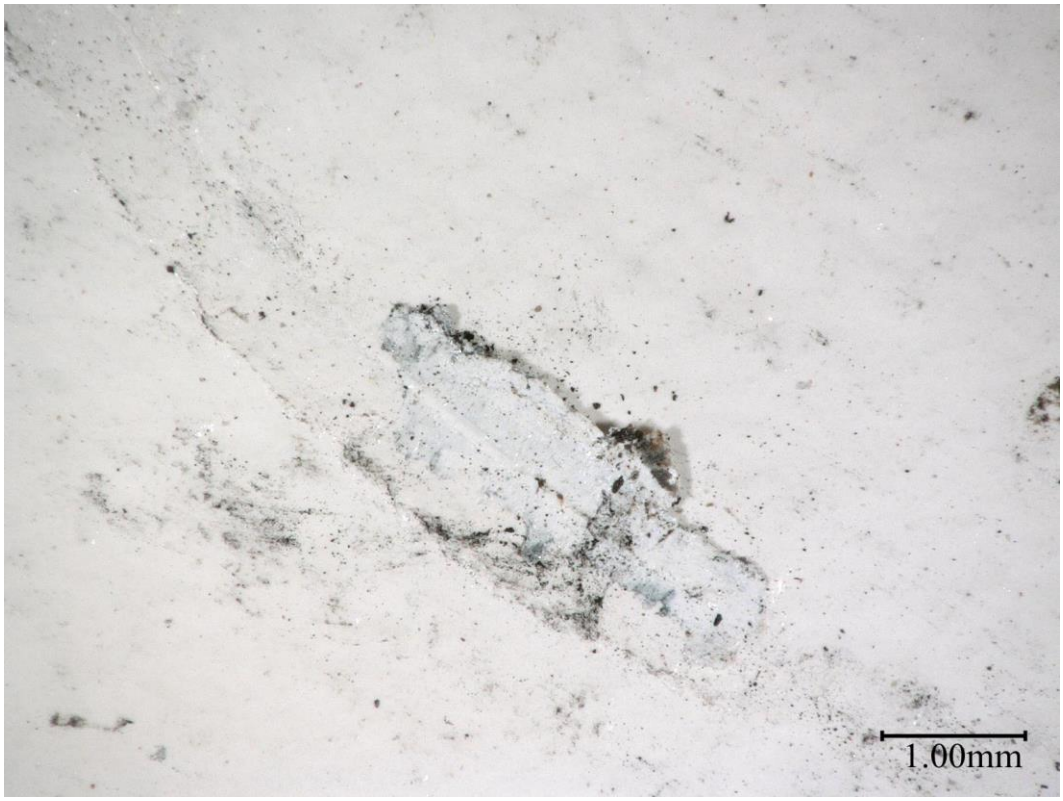


(b) Sample B-1, Box in (a) 50X

Figure 10 Digital microscope images of Sample B-1 after an impact test.

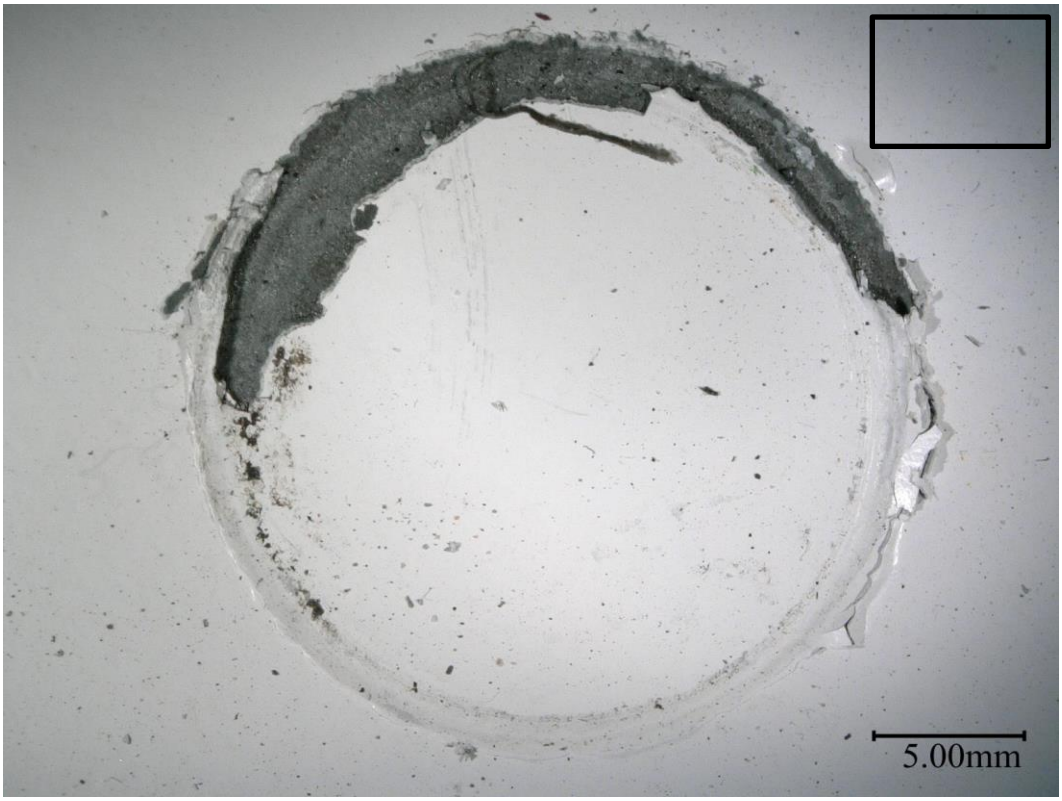


(a) Sample C-1 10X

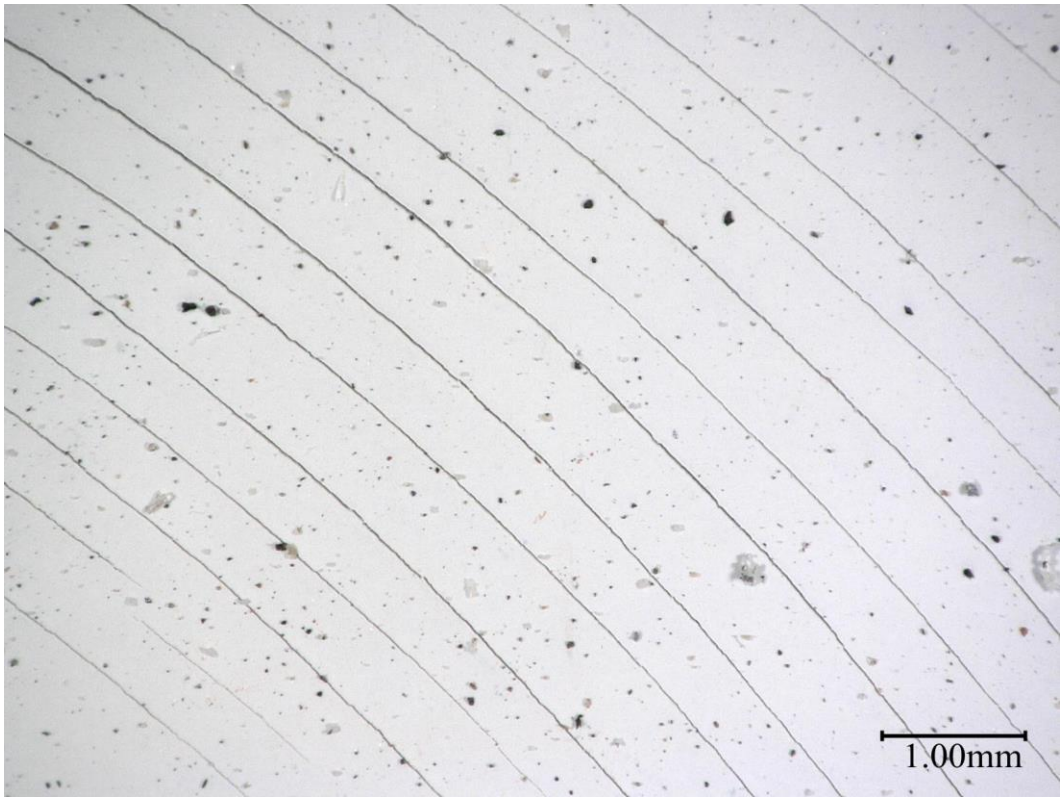


(b) Sample C-1, Box in (a) 50X

Figure 11 Digital microscope images of Sample C-1 after an impact test.

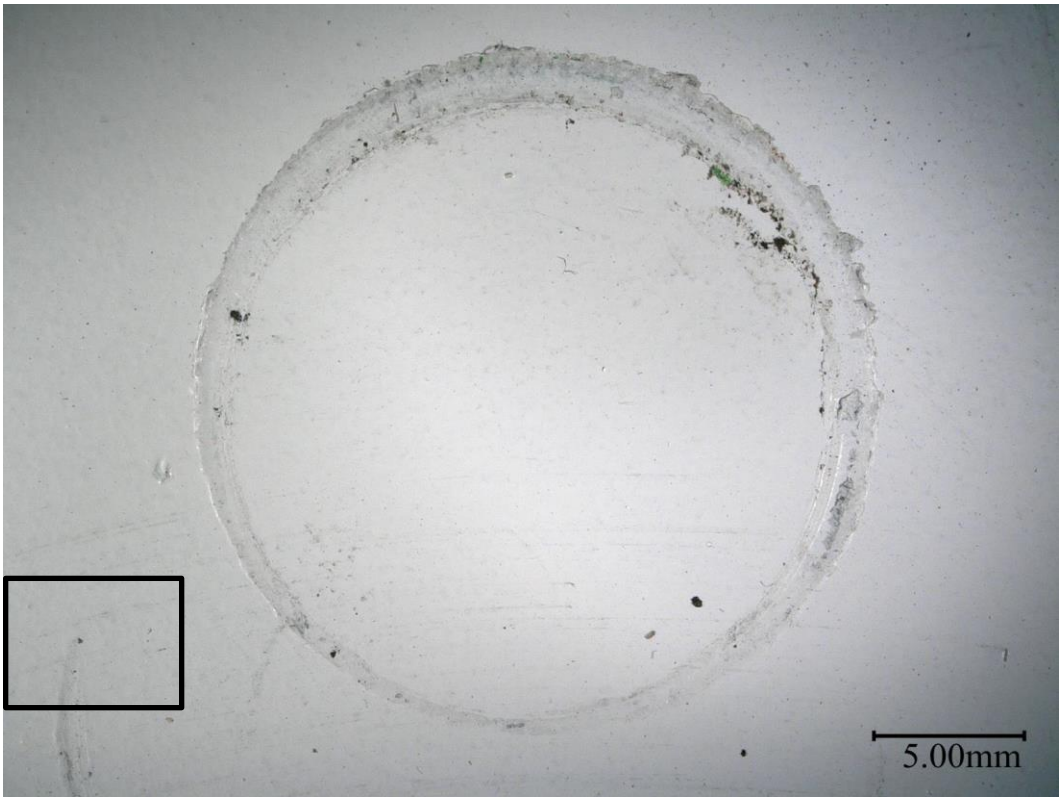


(a) Sample D-1 10X

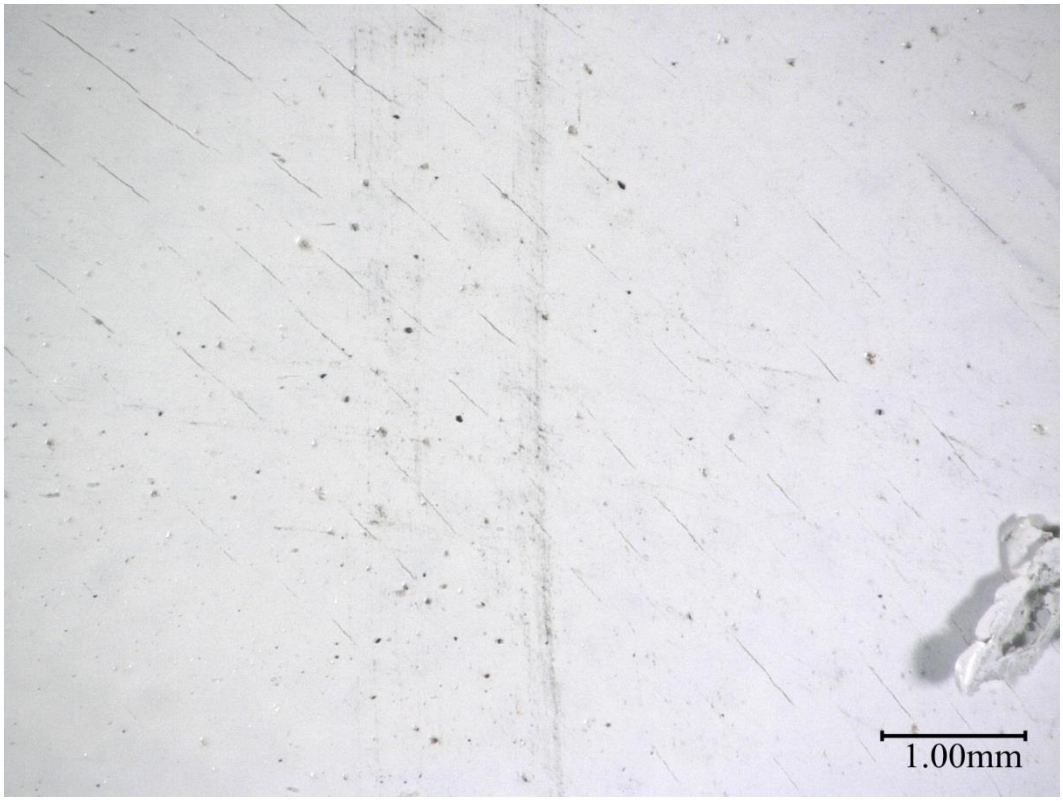


(b) Sample D-1, Box in (a) 50X

Figure 12 Digital microscope images of Sample D-1 after an impact test.

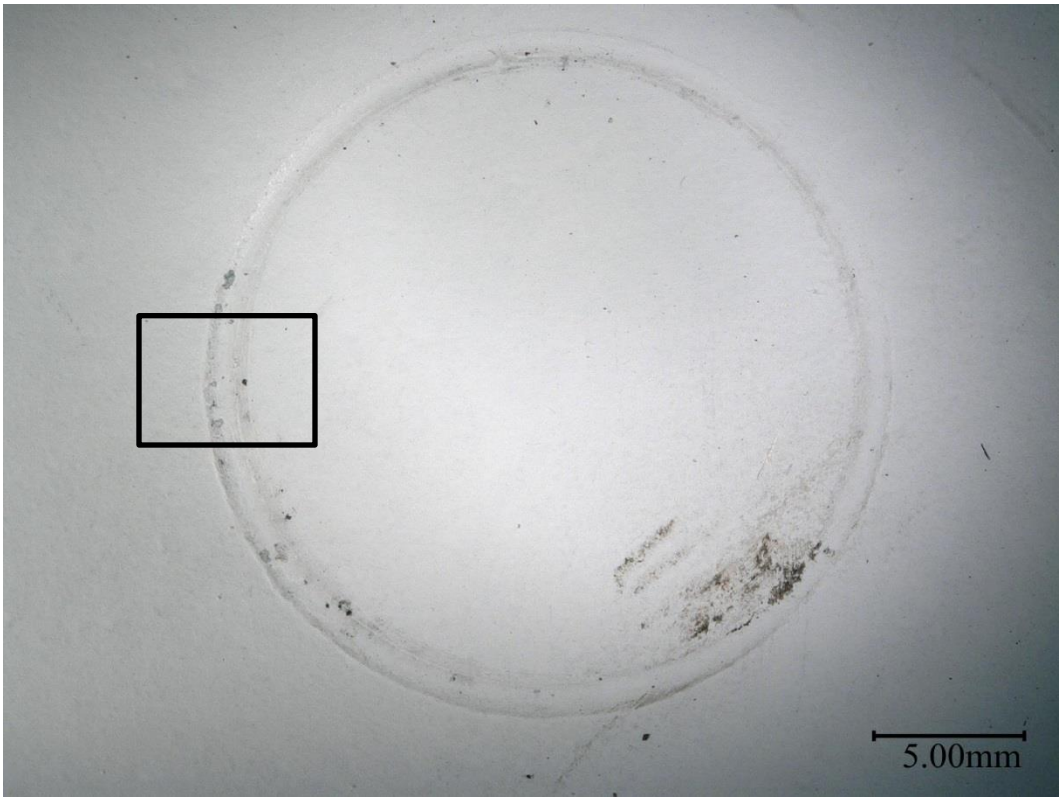


(a) Sample E-1, Box in (a) 10X

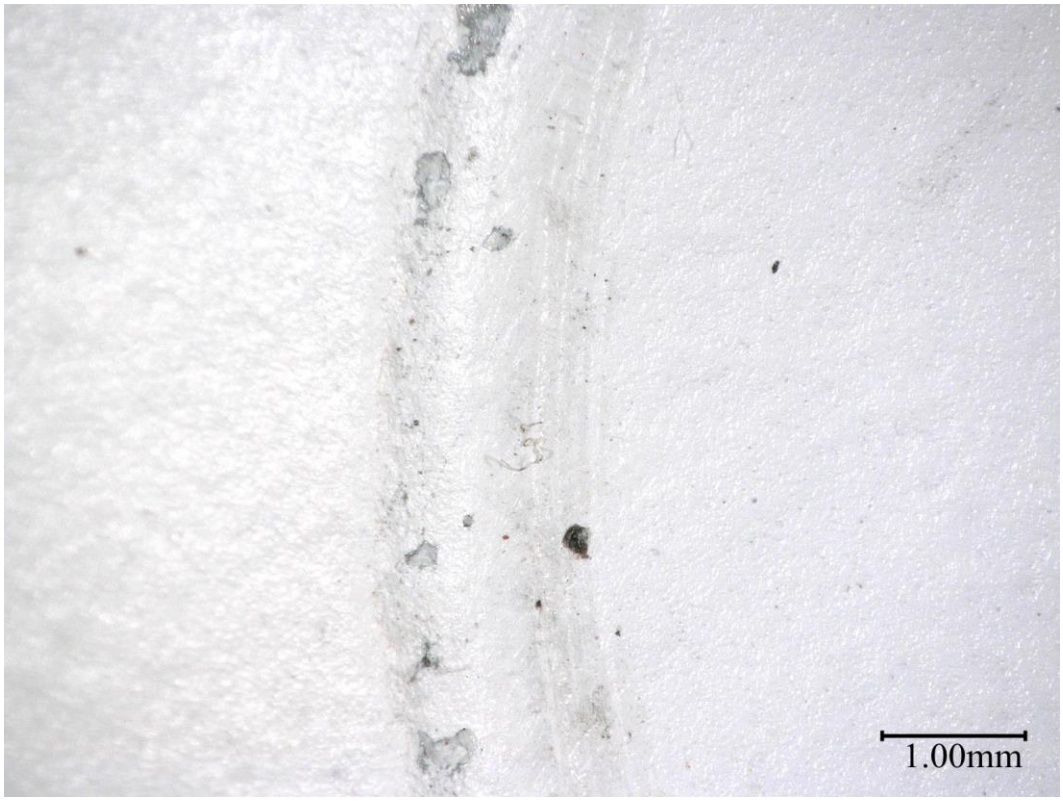


(b) Sample E-1, Box in (a) 50X

Figure 13 Digital microscope images of Sample E-1 after an impact test.

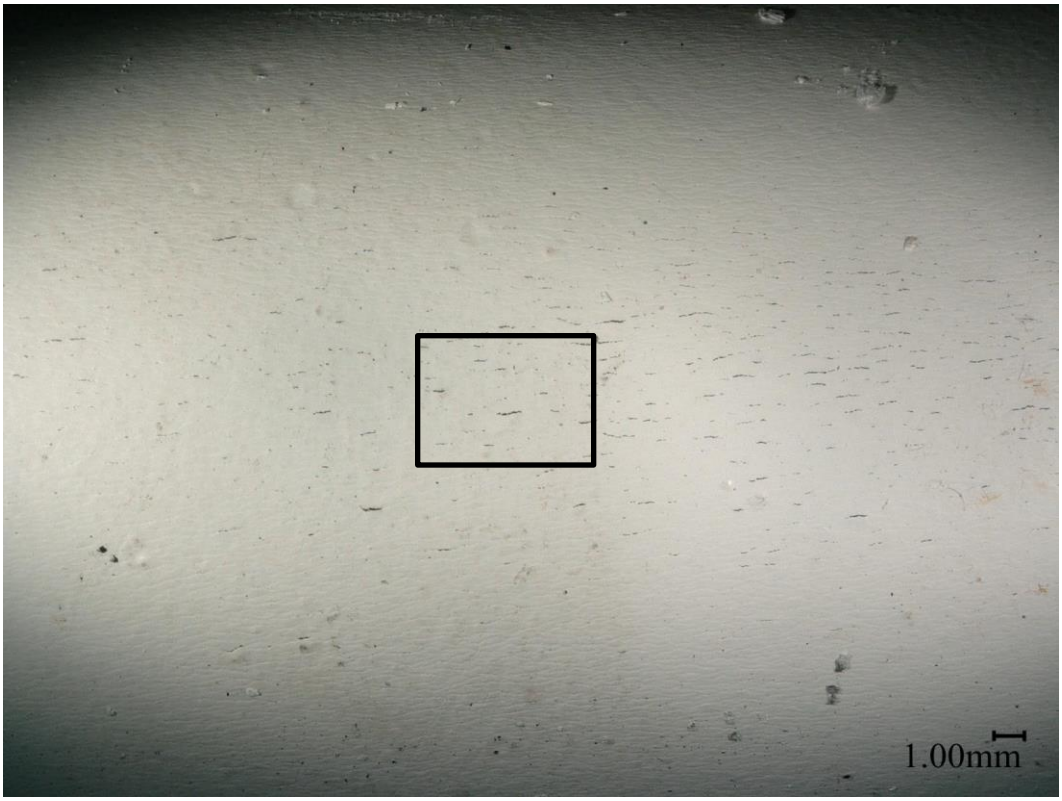


(a) Sample F-1 10X

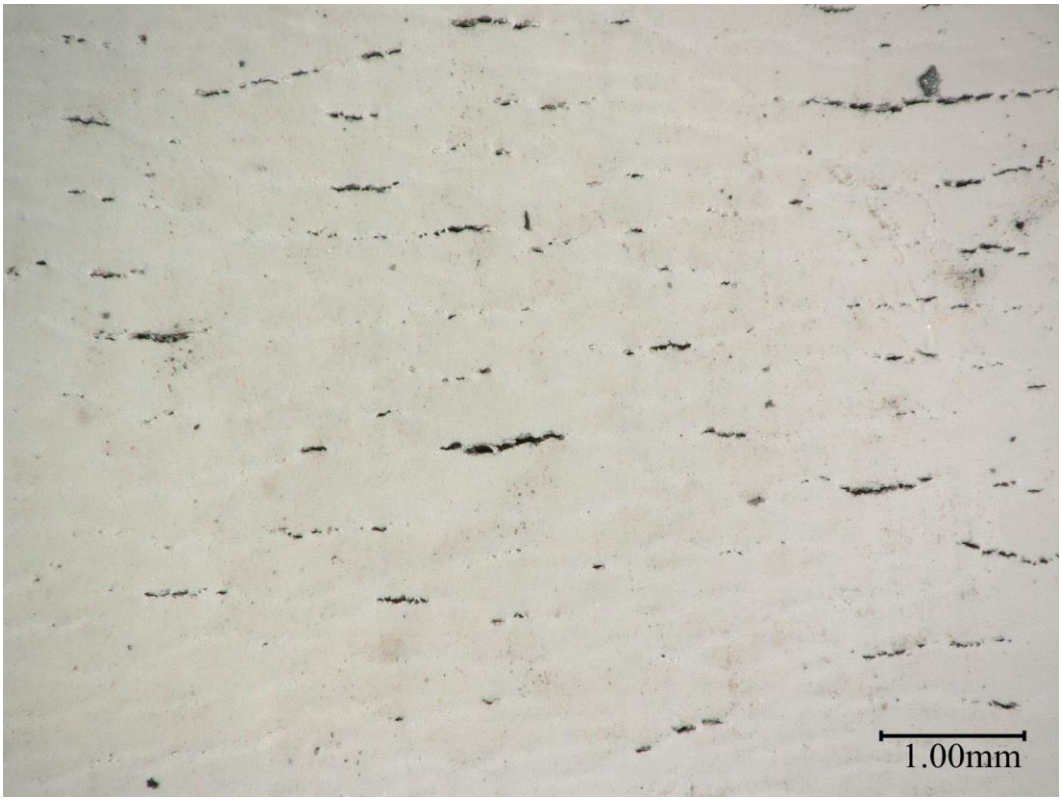


(b) Sample F-1, Box in (a) 50X

Figure 14 Digital microscope images of Sample F-1 after an impact test.

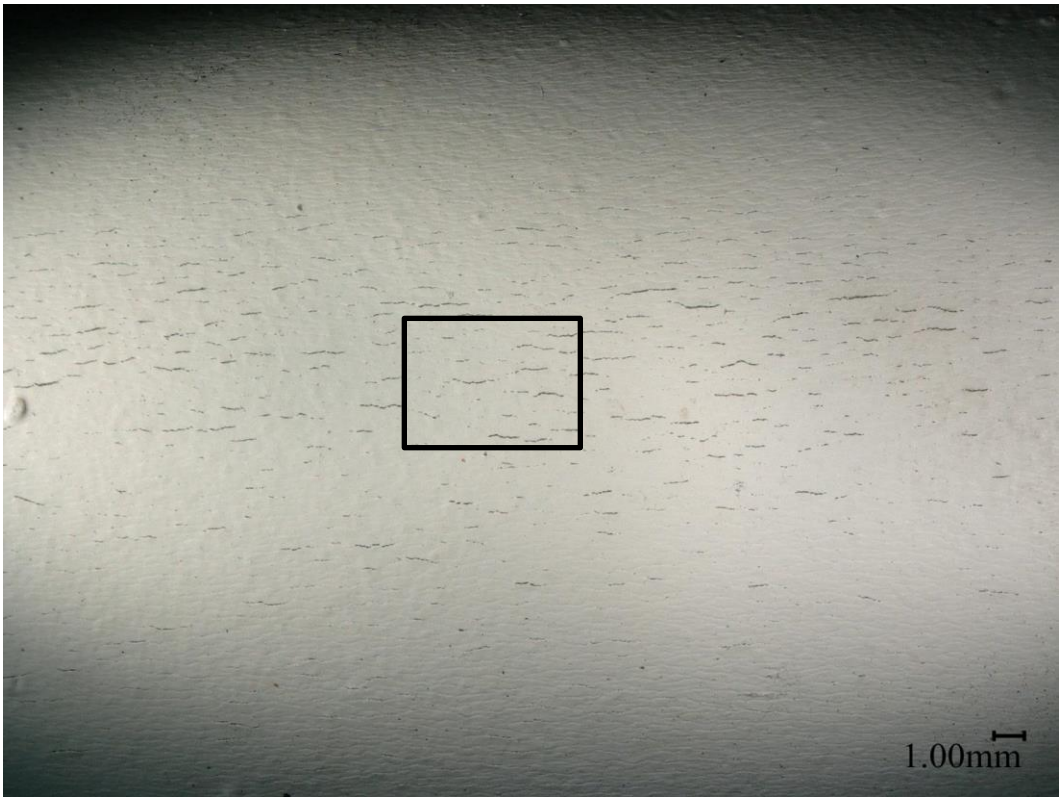


(a) Sample A-2 10X

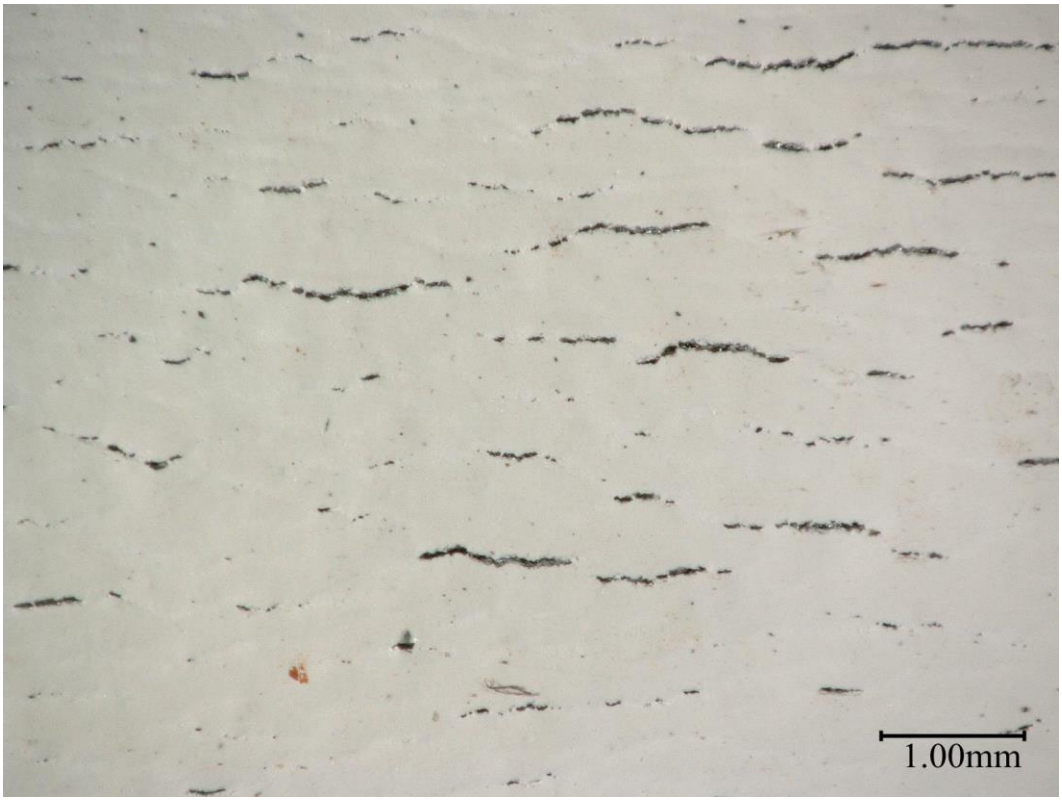


(b) Sample A-2, Box in (a) 50X

Figure 15 Digital microscope images of Sample A-2 after a bend test.

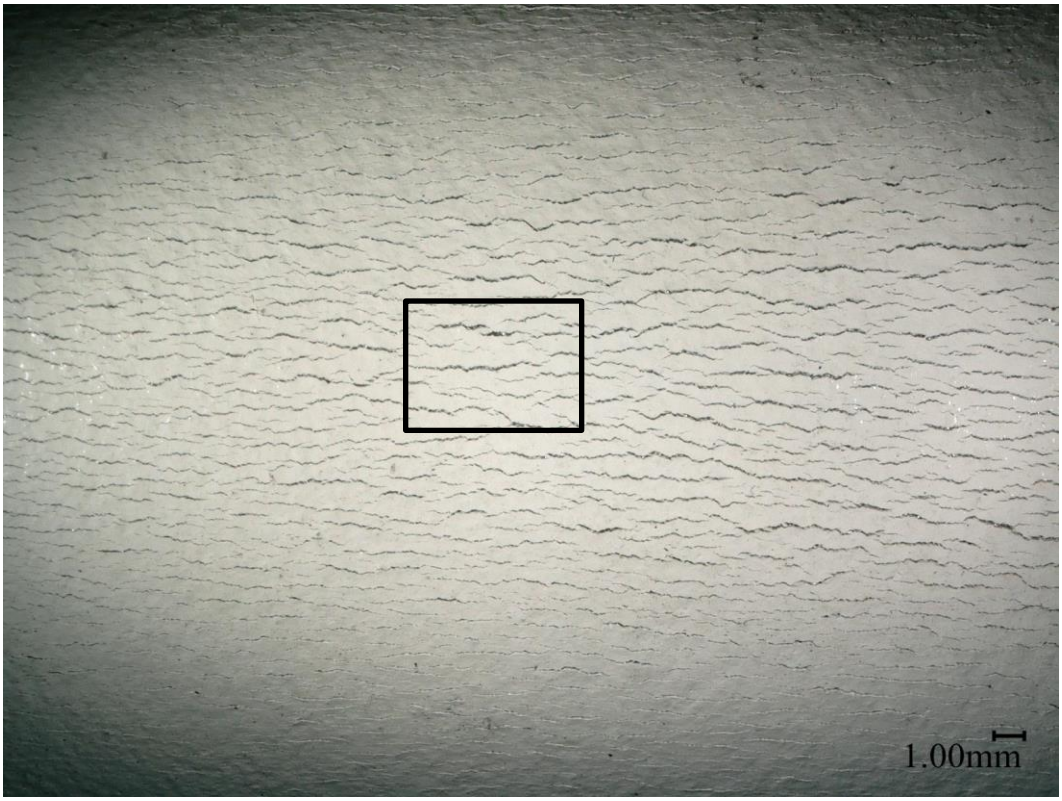


(a) Sample B-2 10X

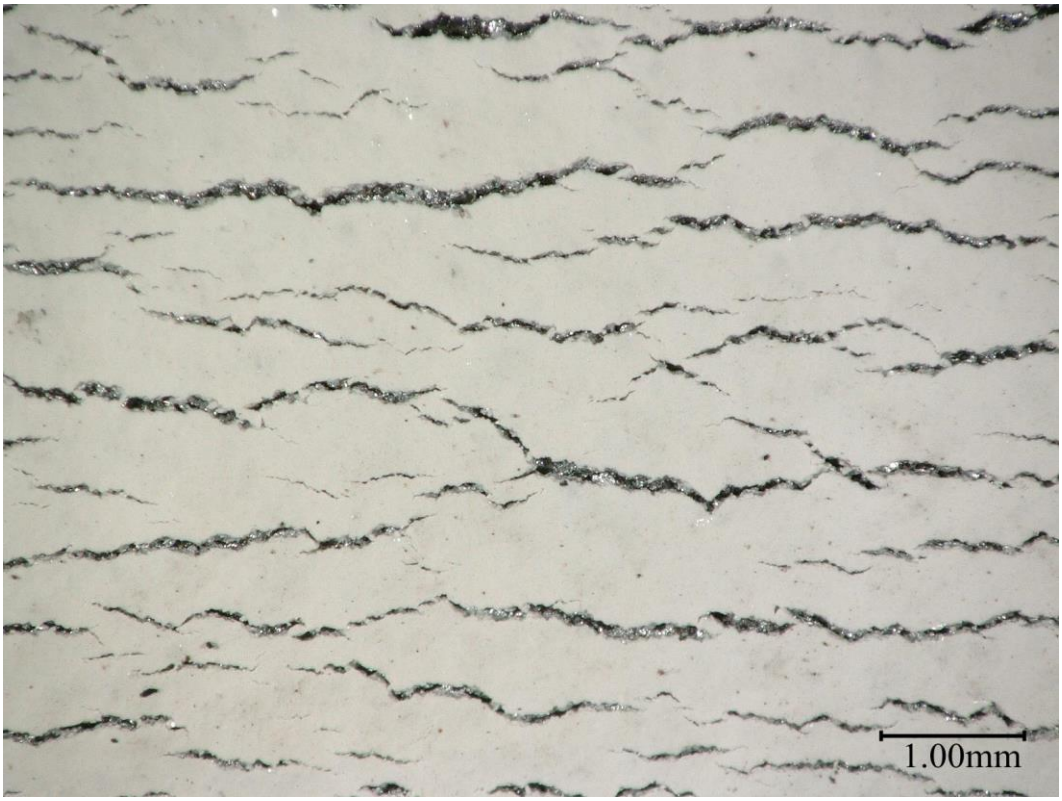


(b) Sample B-2, Box in (a) 50X

Figure 16 Digital microscope images of Sample B-2 after a bend test.

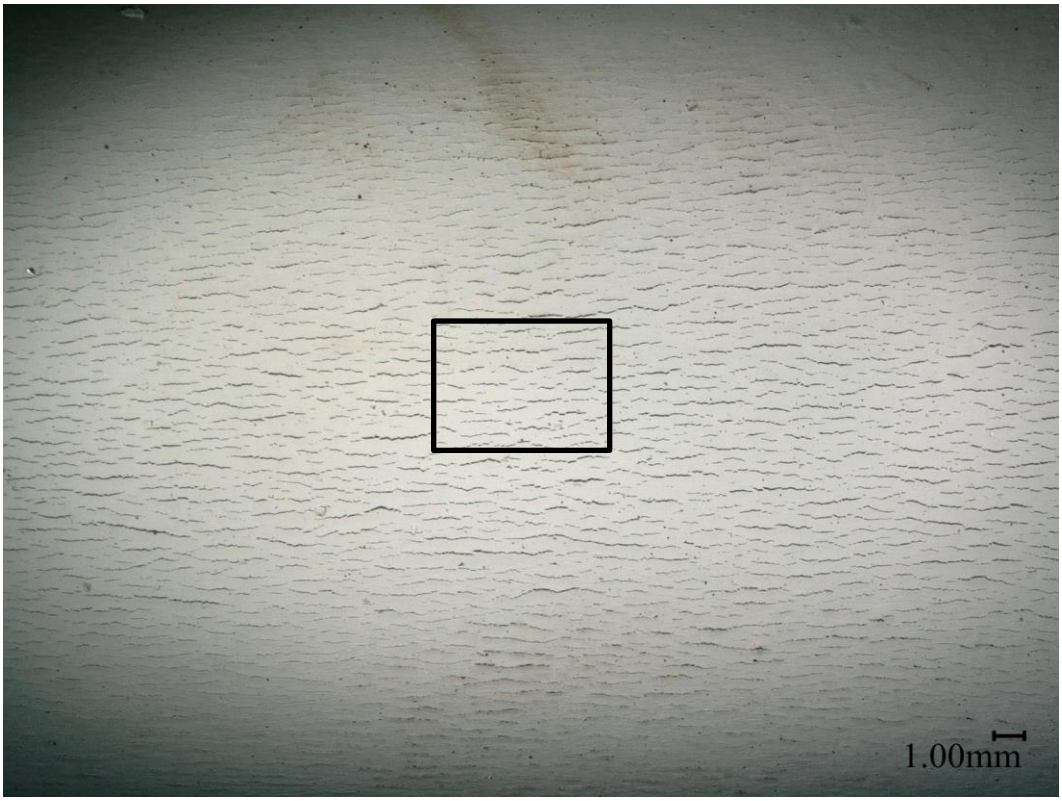


(a) Sample C-2 10X

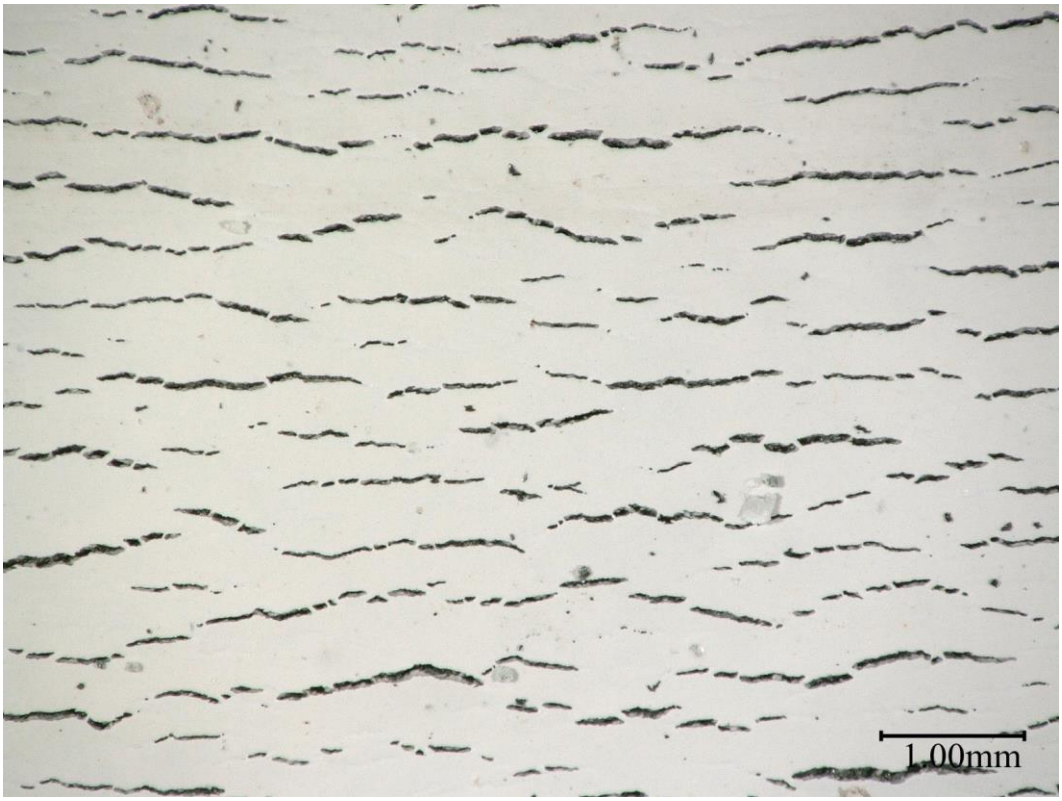


(b) Sample C-2, Box in (a) 50X

Figure 17 Digital microscope images of Sample C-2 after a bend test.

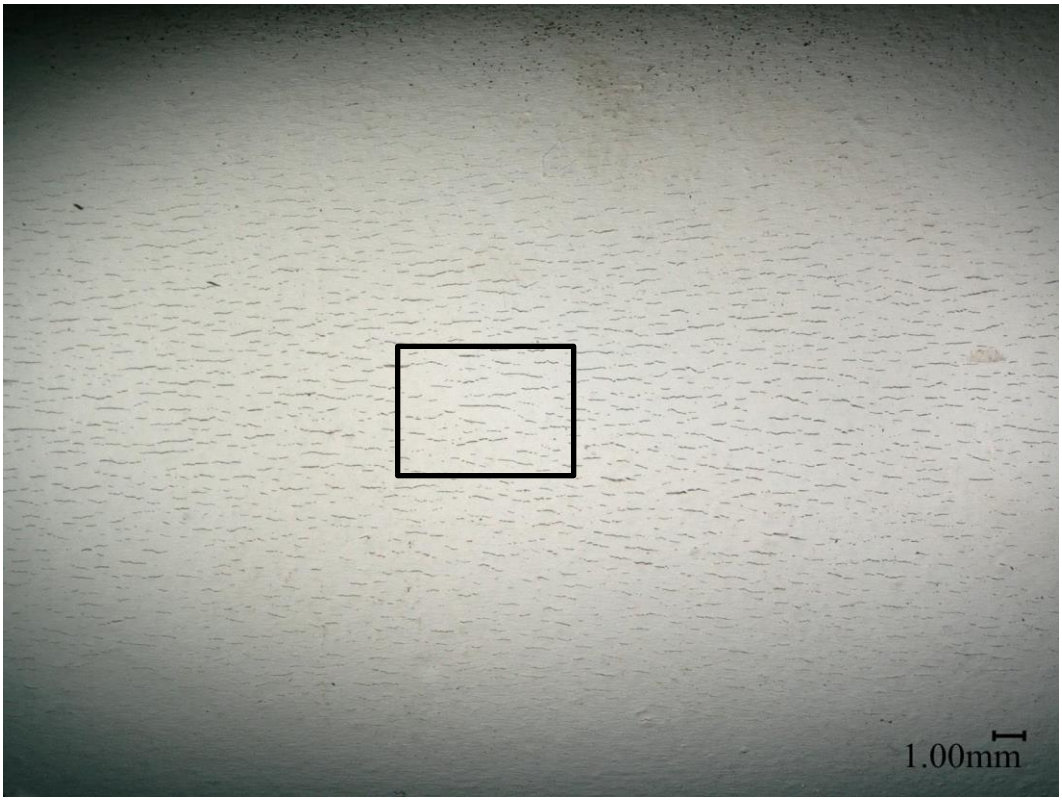


(a) Sample D-2 10X

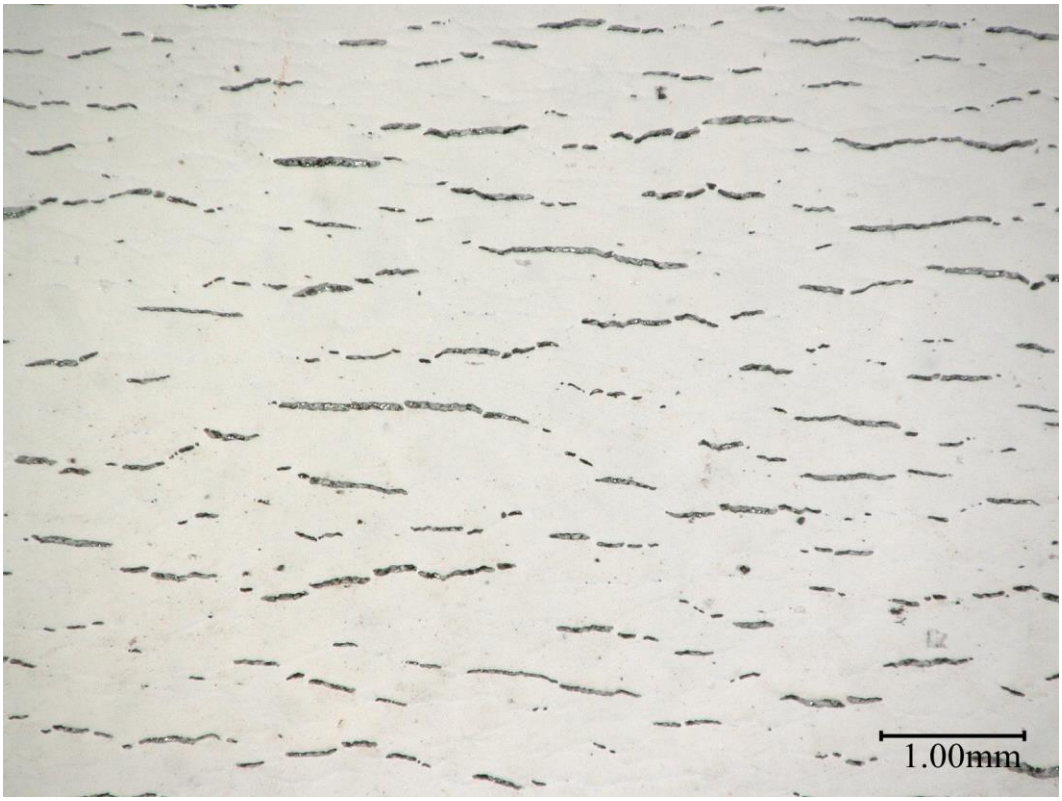


(b) Sample D-2, Box in (a) 50X

Figure 18 Digital microscope images of Sample D-2 after a bend test.

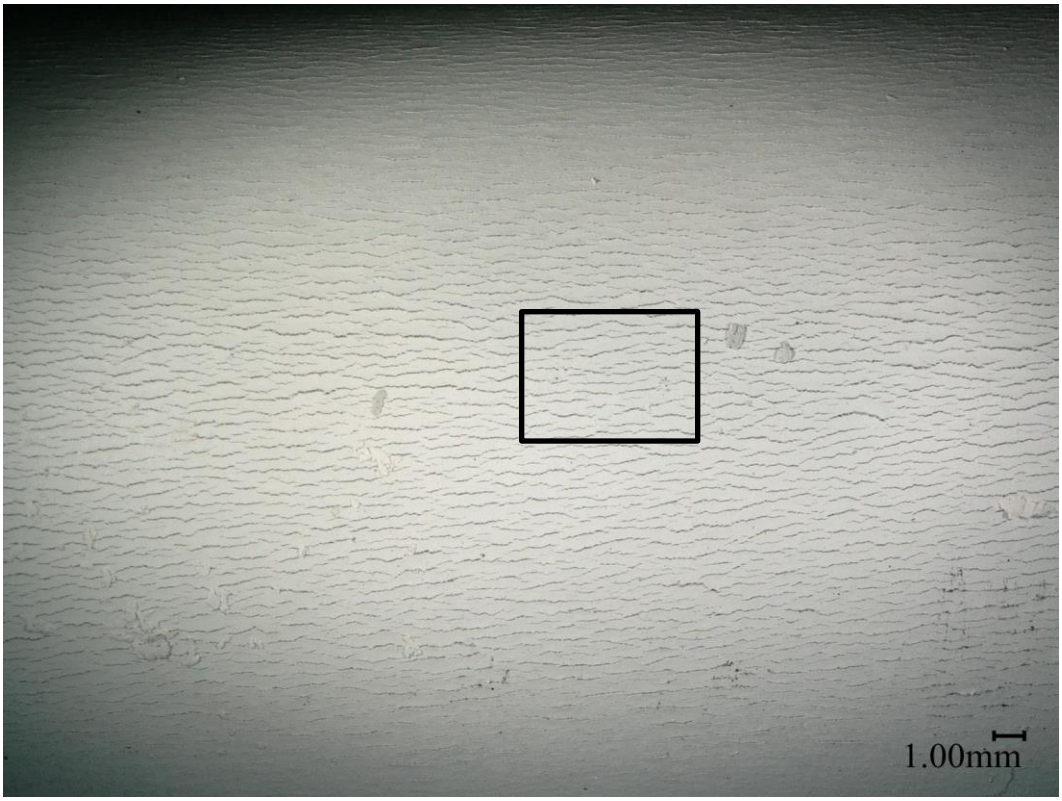


(a) Sample E-2 10X

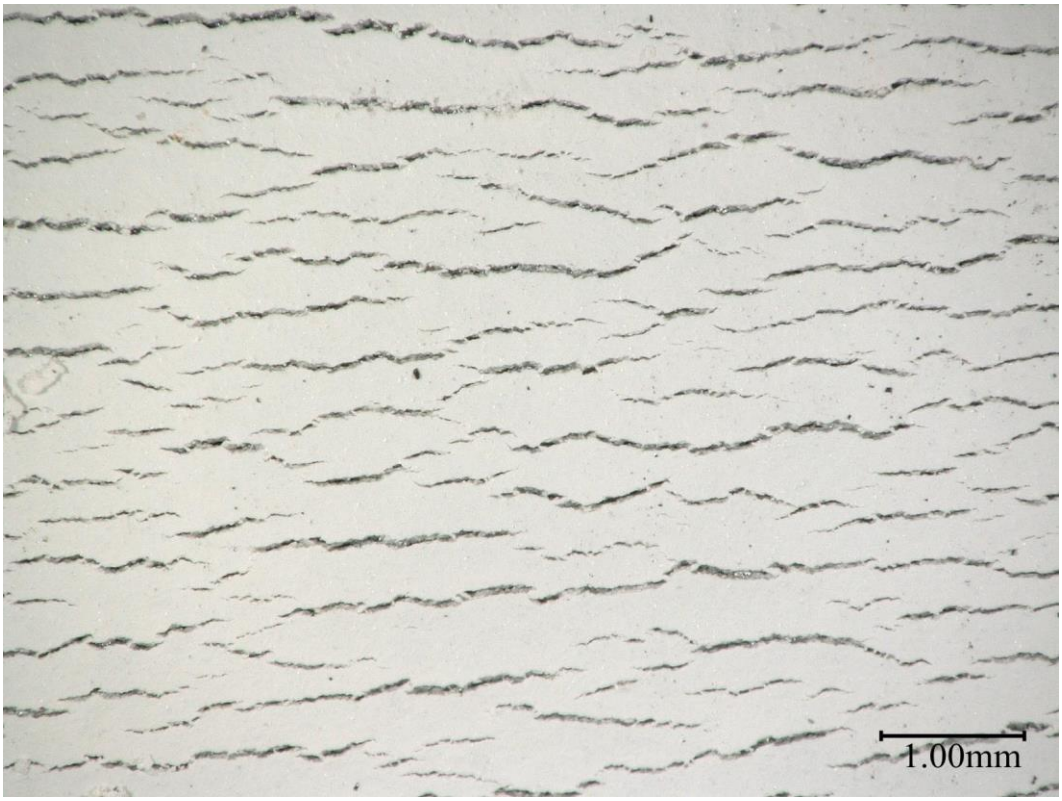


(b) Sample E-2, Box in (a) 50X

Figure 19 Digital microscope images of Sample E-2 after a bend test.



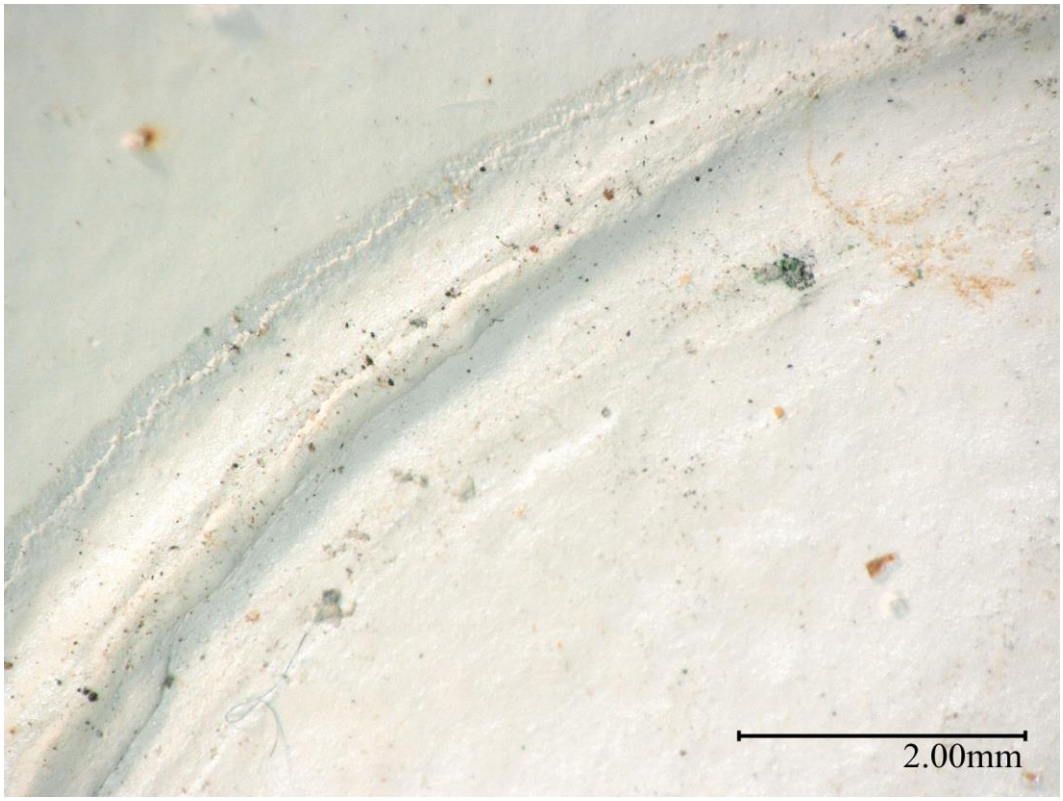
(a) Sample F-2 10X



(b) Sample F-2, Box in (a) 50X

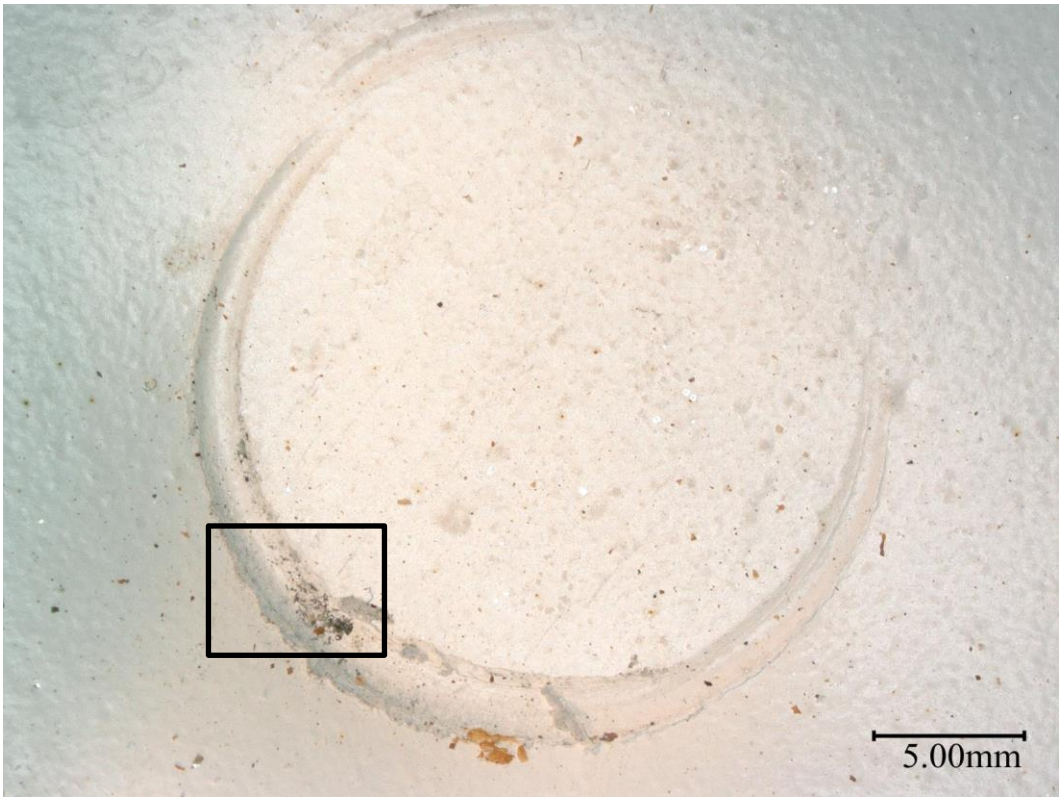
Figure 20 Digital microscope images of Sample F-2 after a bend test.

(a) Sample A-1 10X

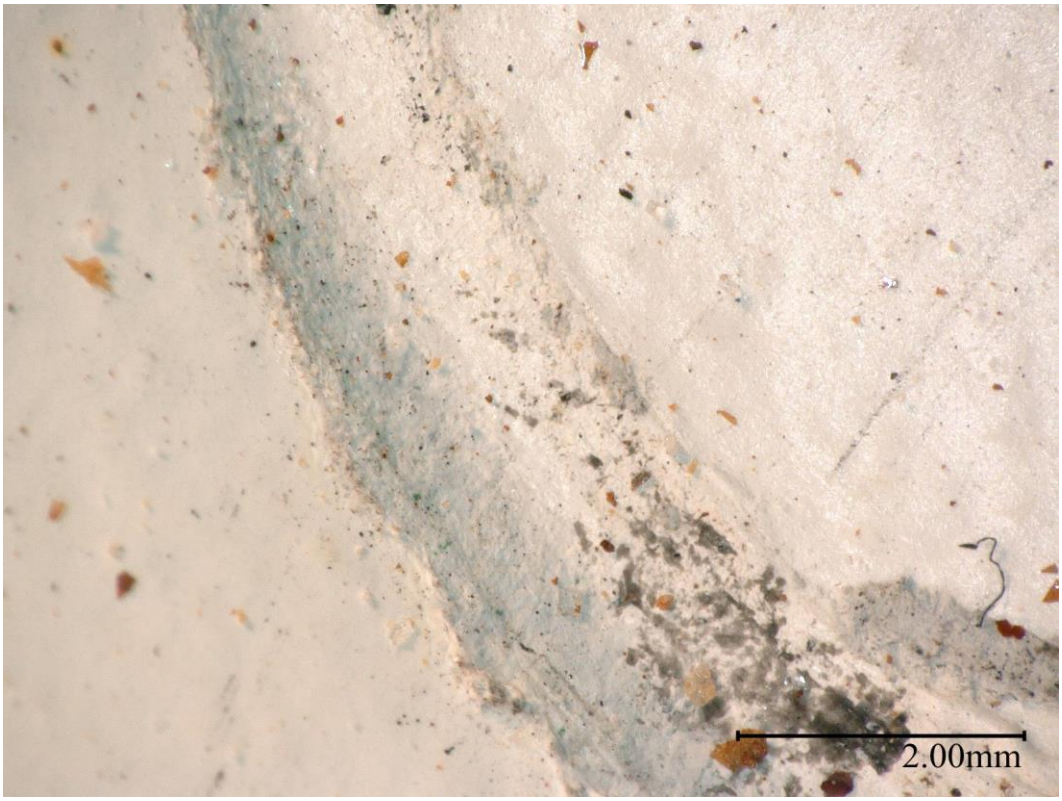


(b) Sample A-1, Box in (a) 50X

Figure 21 Digital microscope images of Sample A-1 after an impact test and salt spray.

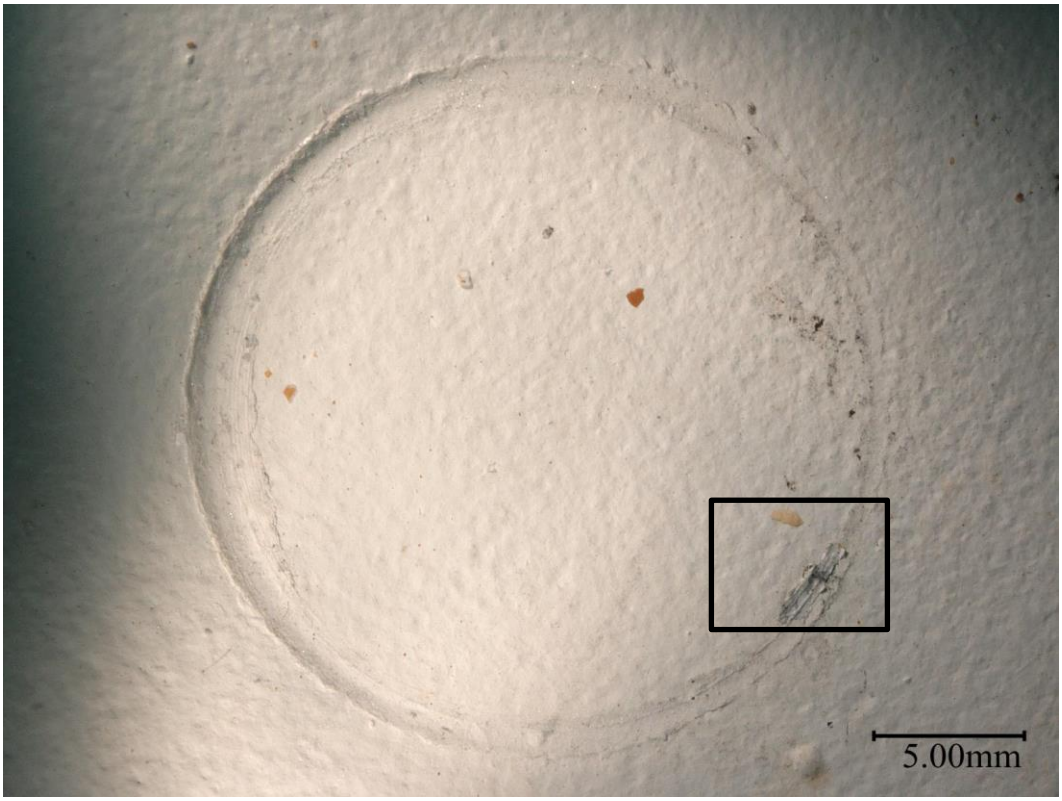


(a) Sample B-1 10X

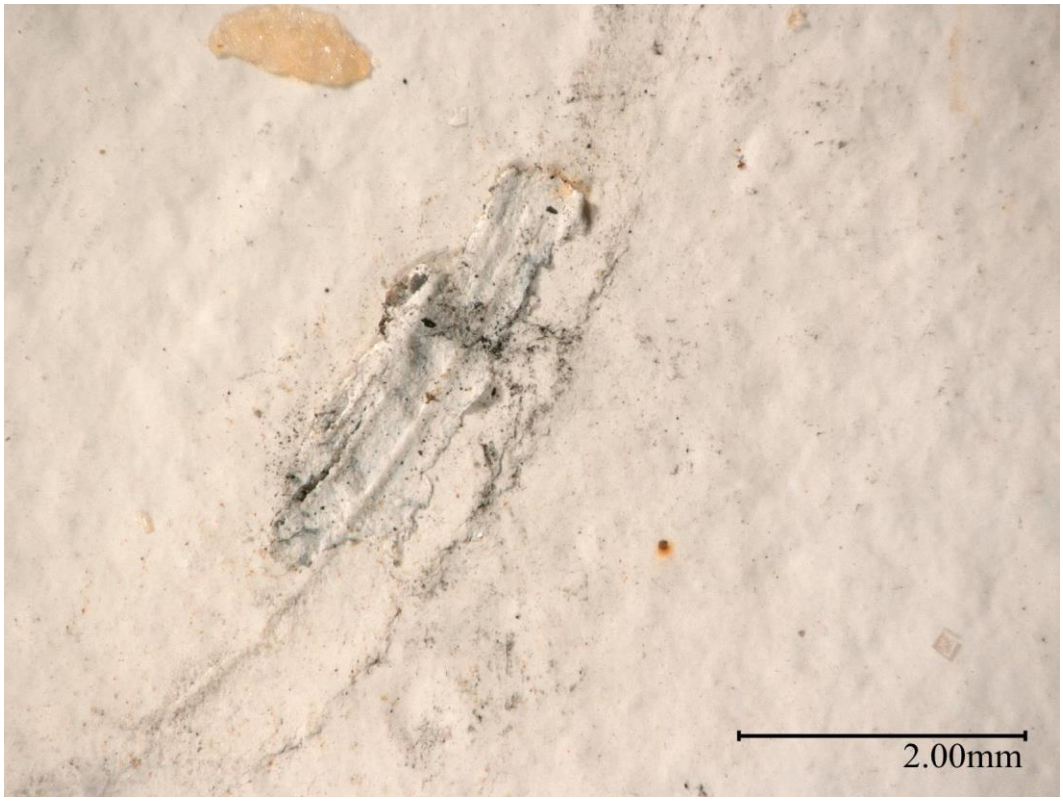


(b) Sample B-1, Box in (a) 50X

Figure 22 Digital microscope images of Sample B-1 after an impact test and salt spray.

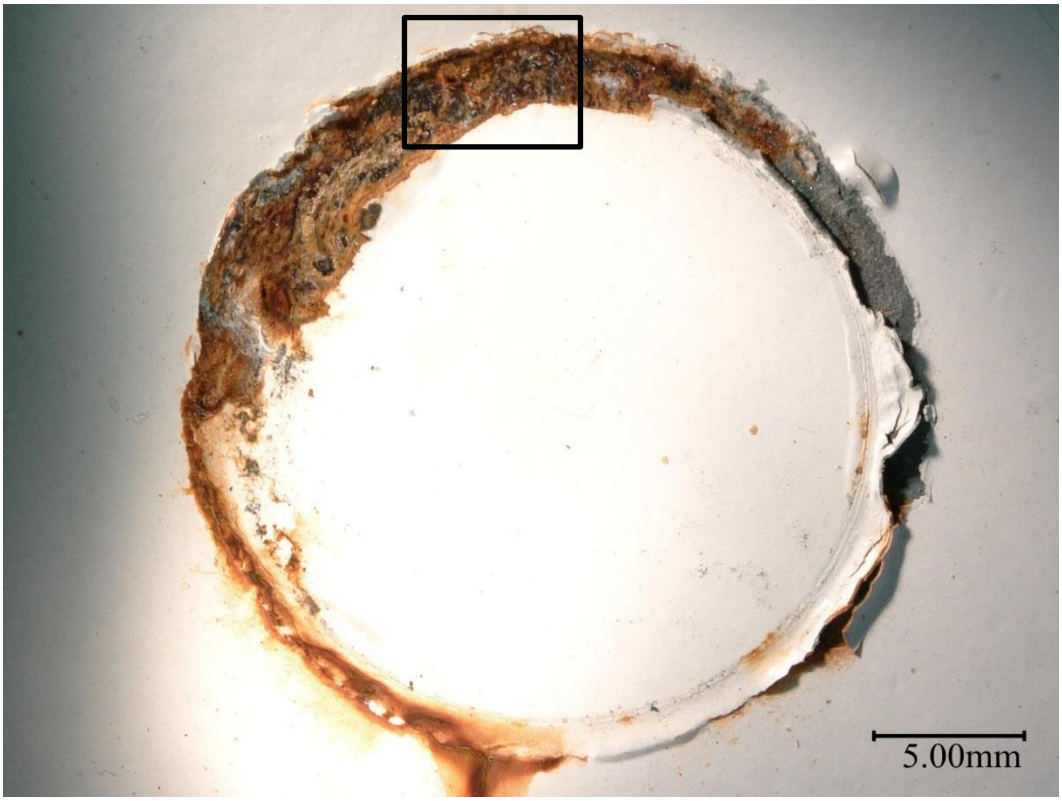


(a) Sample C-1 10X



(b) Sample C-1, Box in (a) 50X

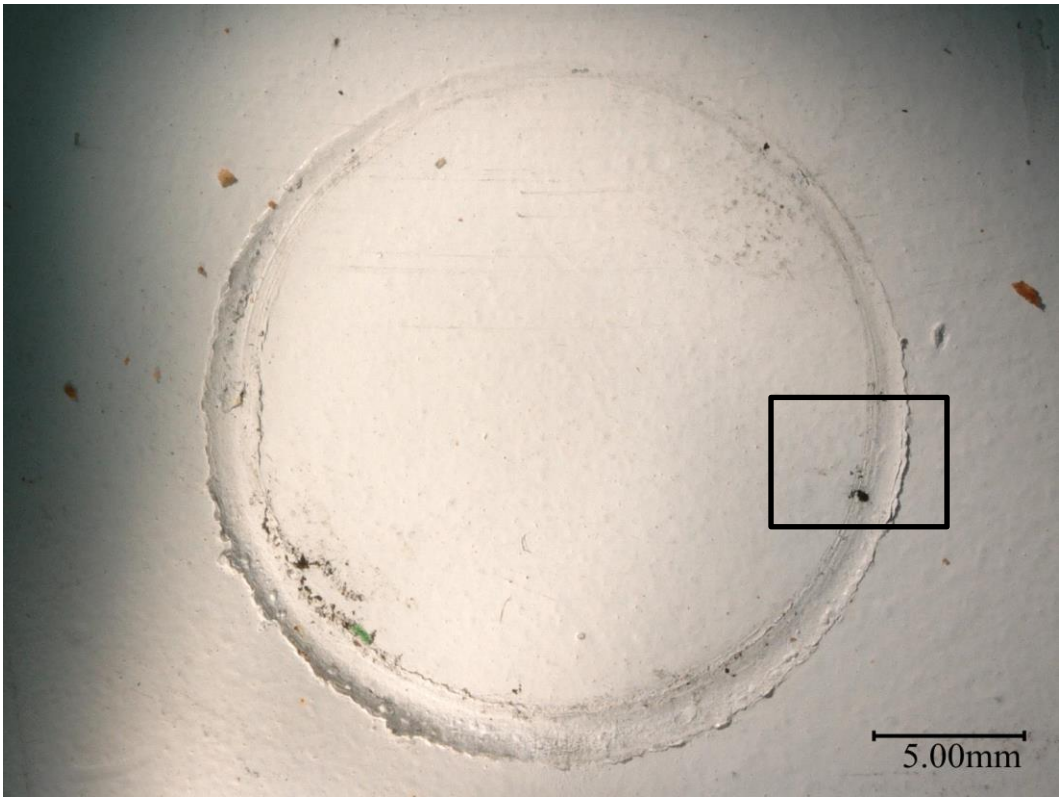
Figure 23 Digital microscope images of Sample C-1 after an impact test and salt spray.



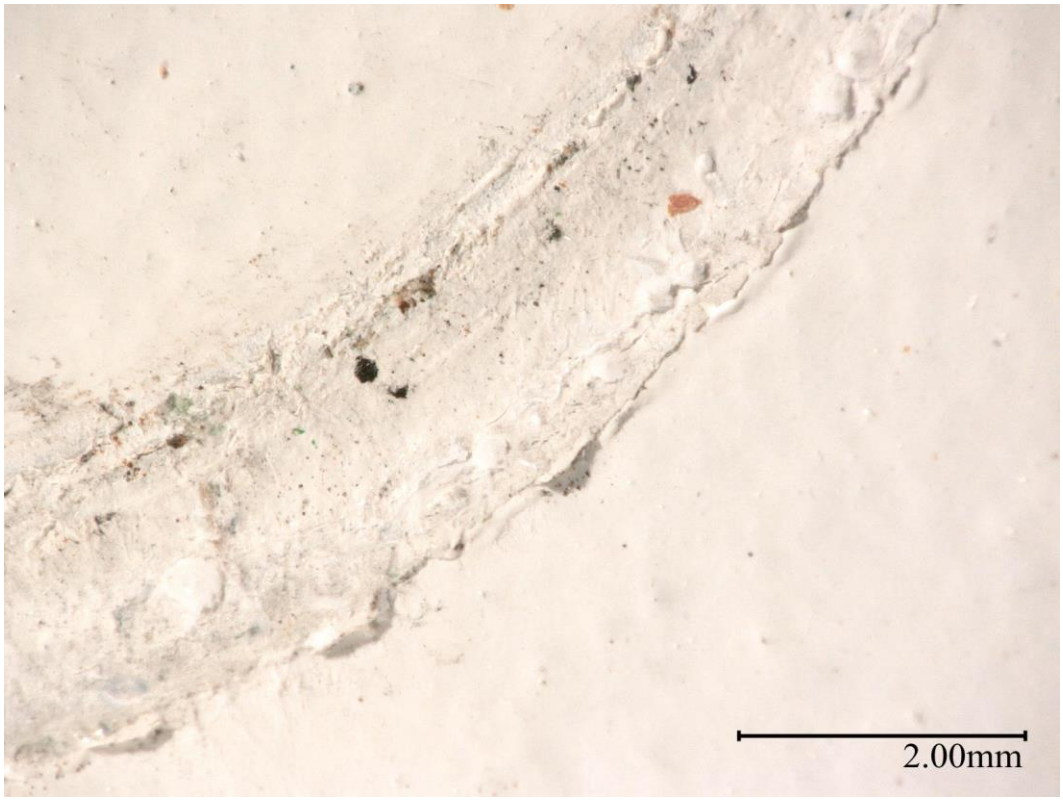
(a) Sample D-1 10X

(b) Sample D-1, Box in (a) 50X

Figure 24 Digital microscope images of Sample D-1 after an impact test and salt spray.

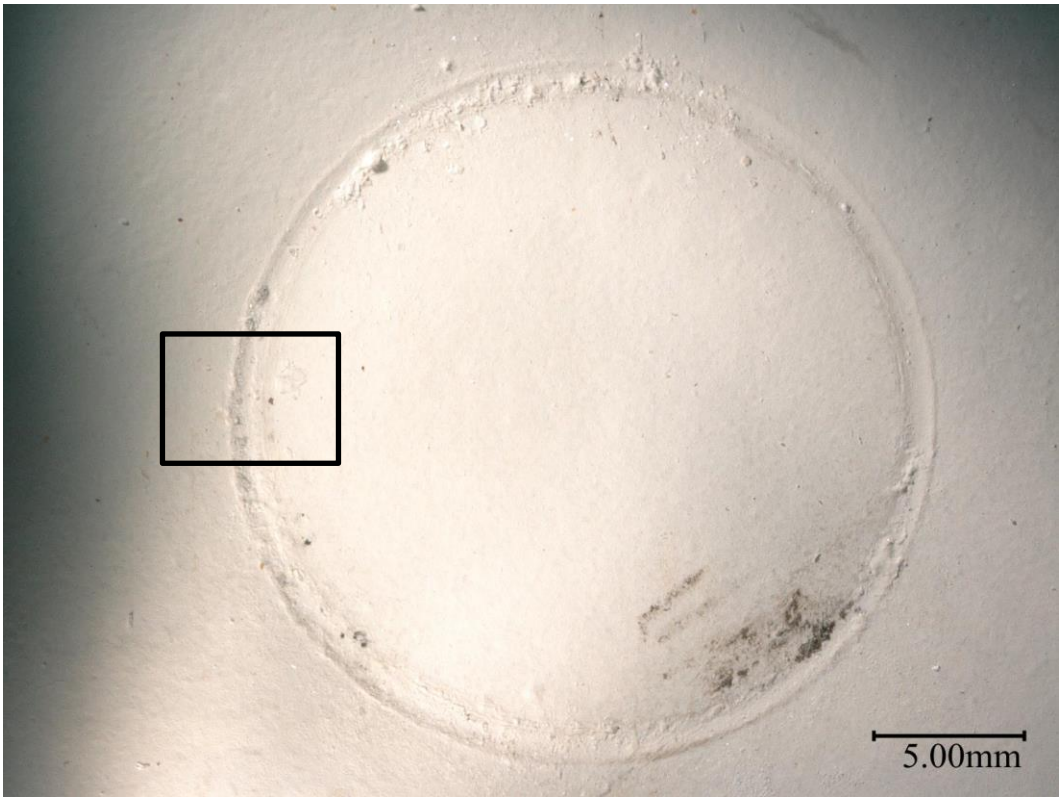


(a) Sample E-1 10X

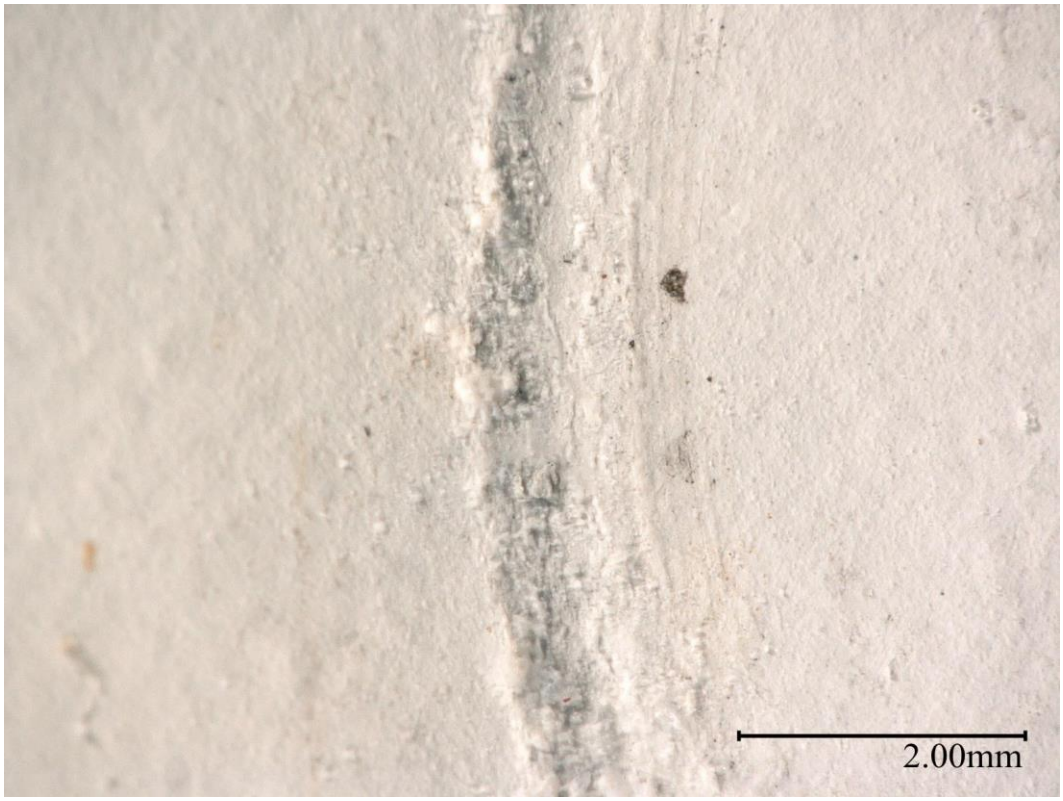


(b) Sample E-1, Box in (a) 50X

Figure 25 Digital microscope images of Sample E-1 after an impact test and salt spray.

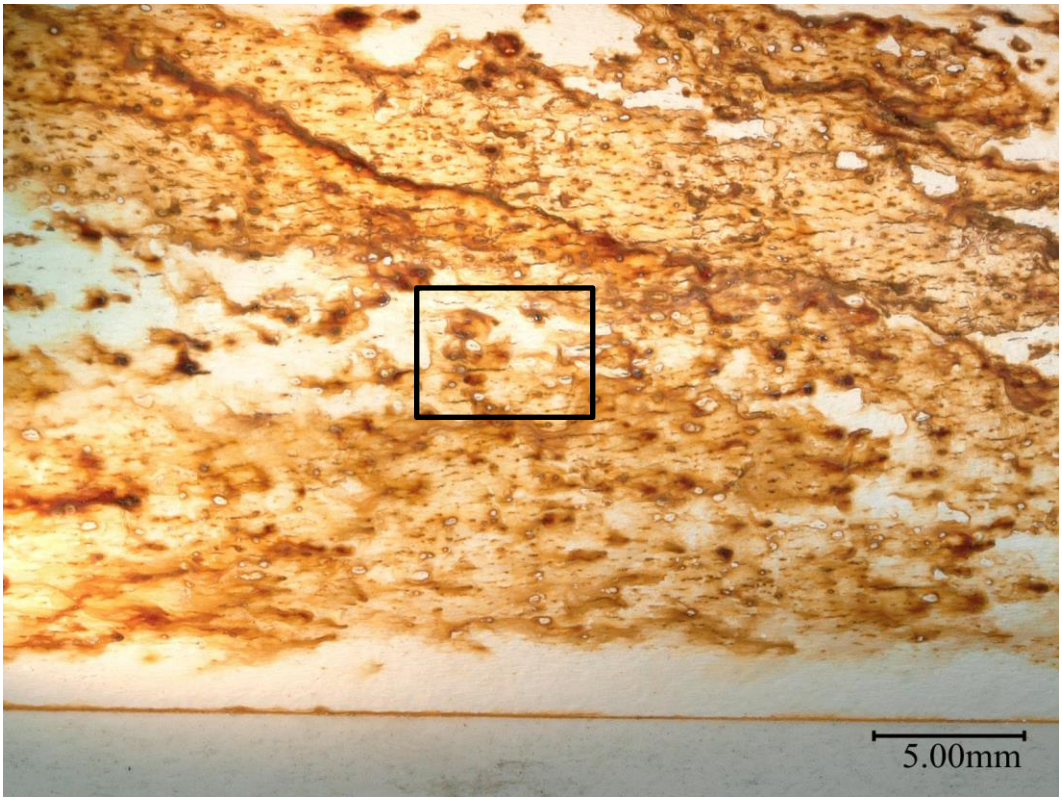


(a) Sample F-1 10X

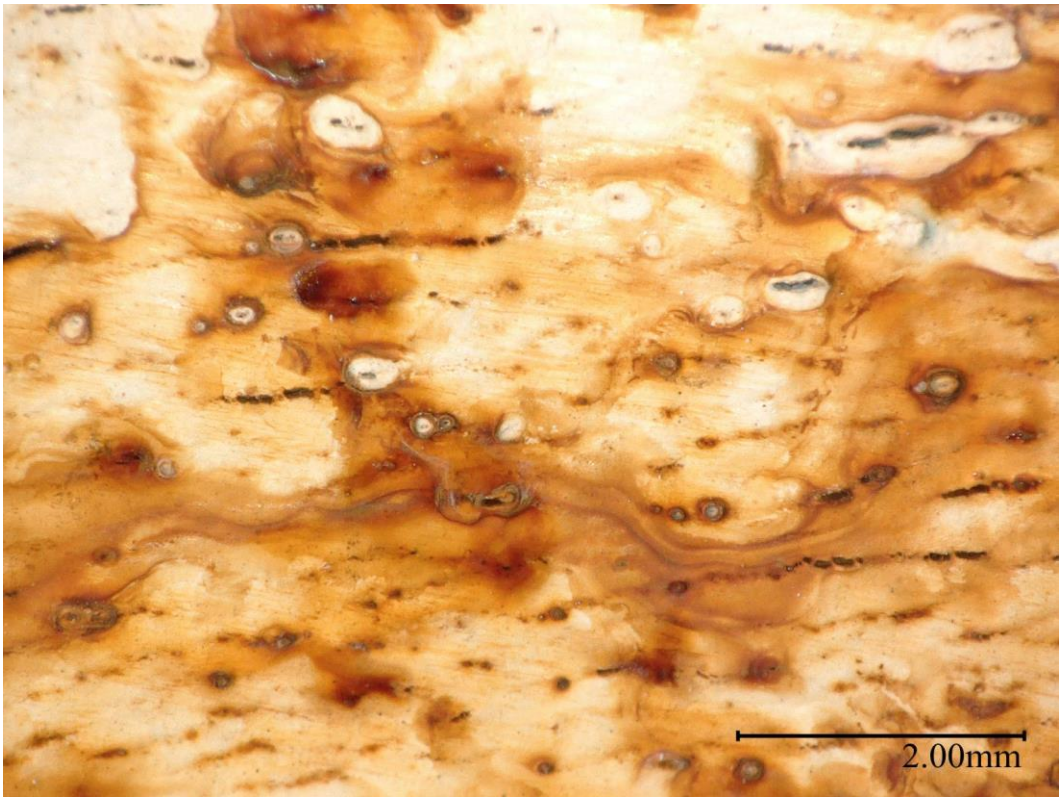


(b) Sample F-1, Box in (a) 50X

Figure 26 Digital microscope images of Sample F-1 after an impact test and salt spray.

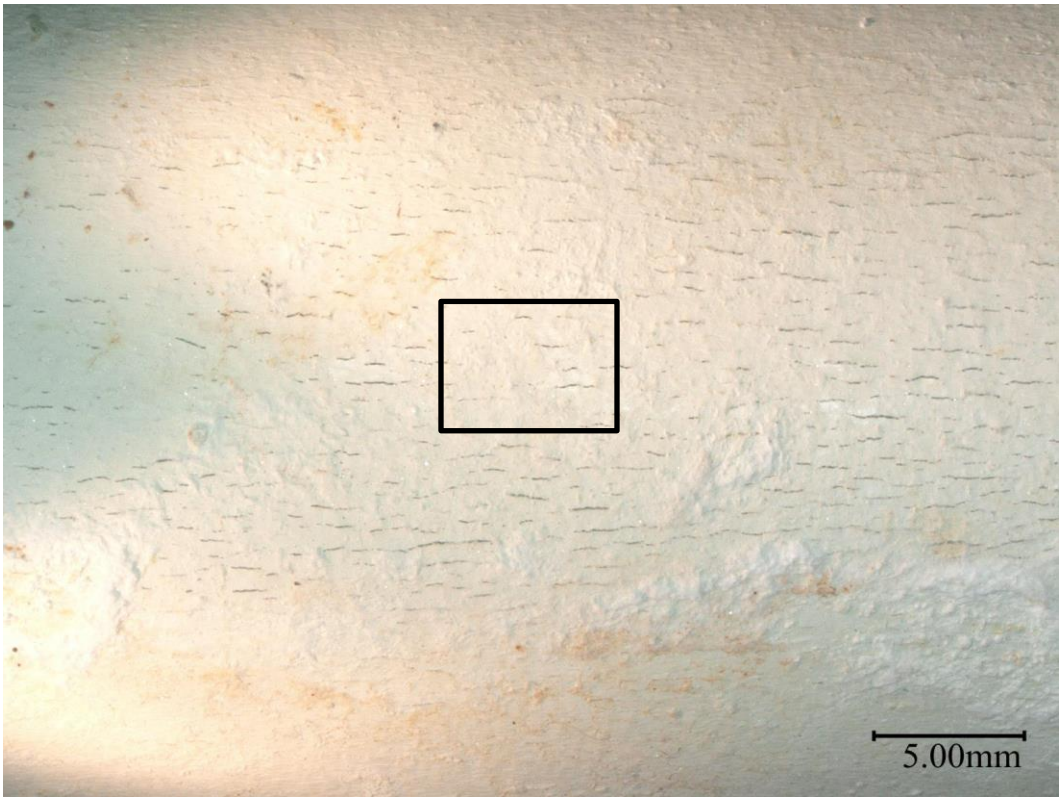


(a) Sample A-2 10X

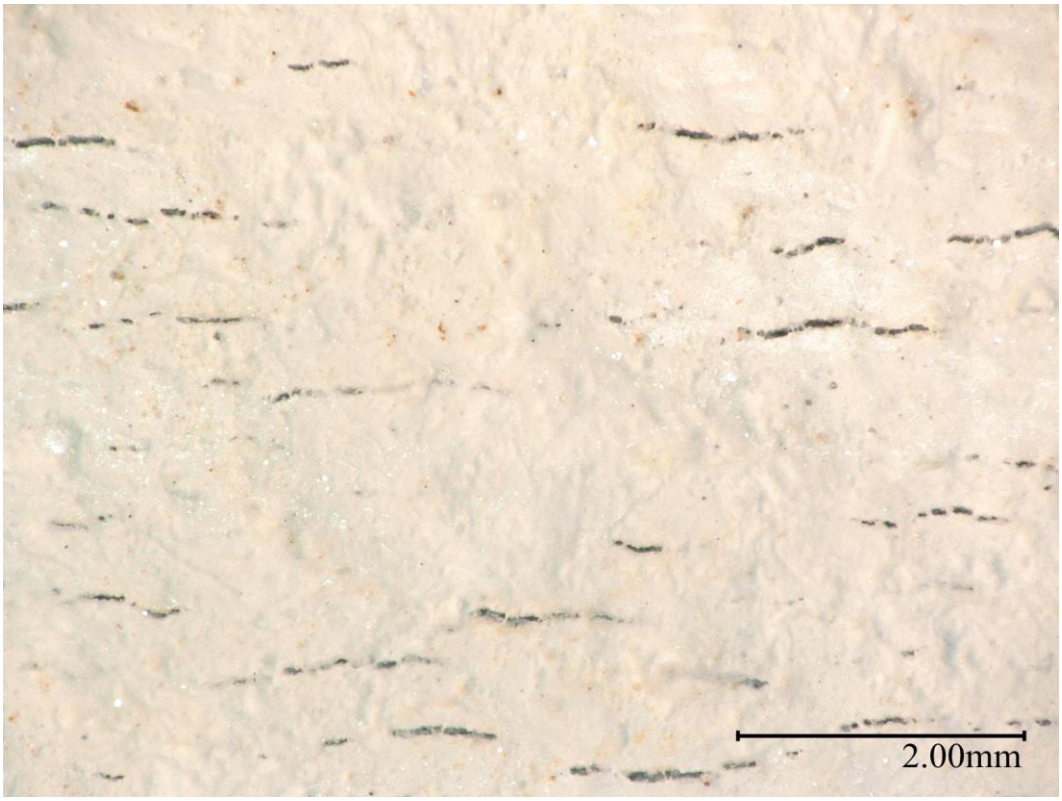


(b) Sample A-2, Box in (a) 50X

Figure 27 Digital microscope images of Sample A-2 after a bend test and salt spray.

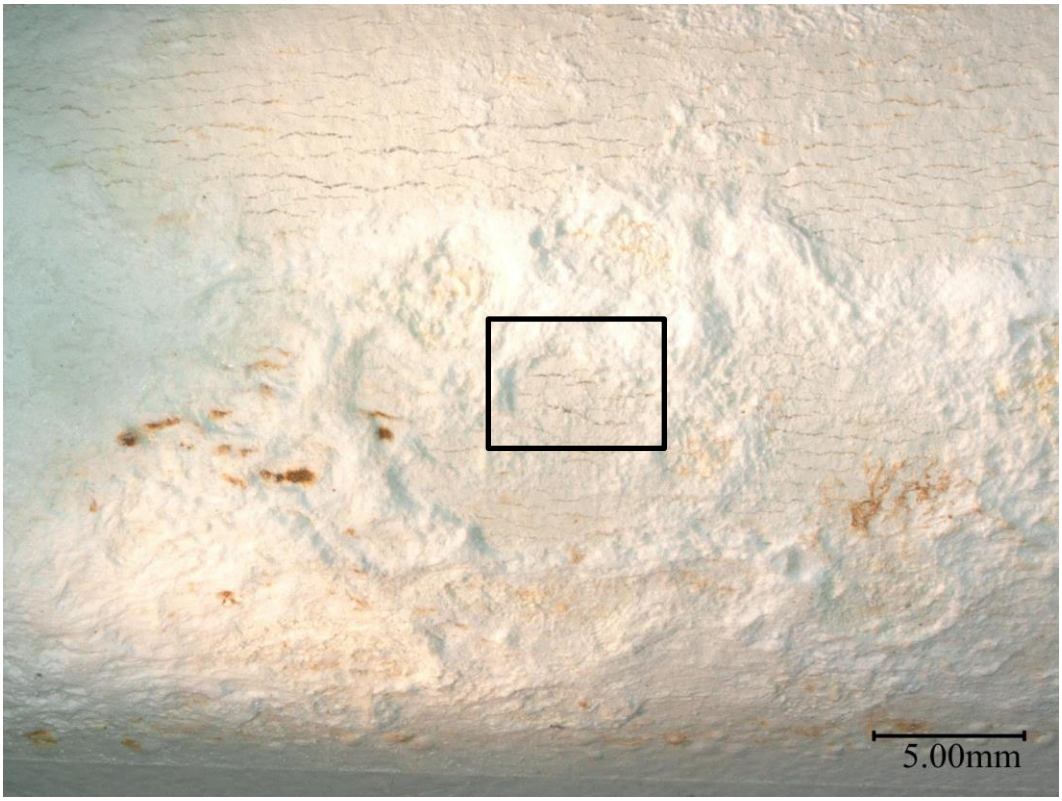


(a) Sample B-2 10X

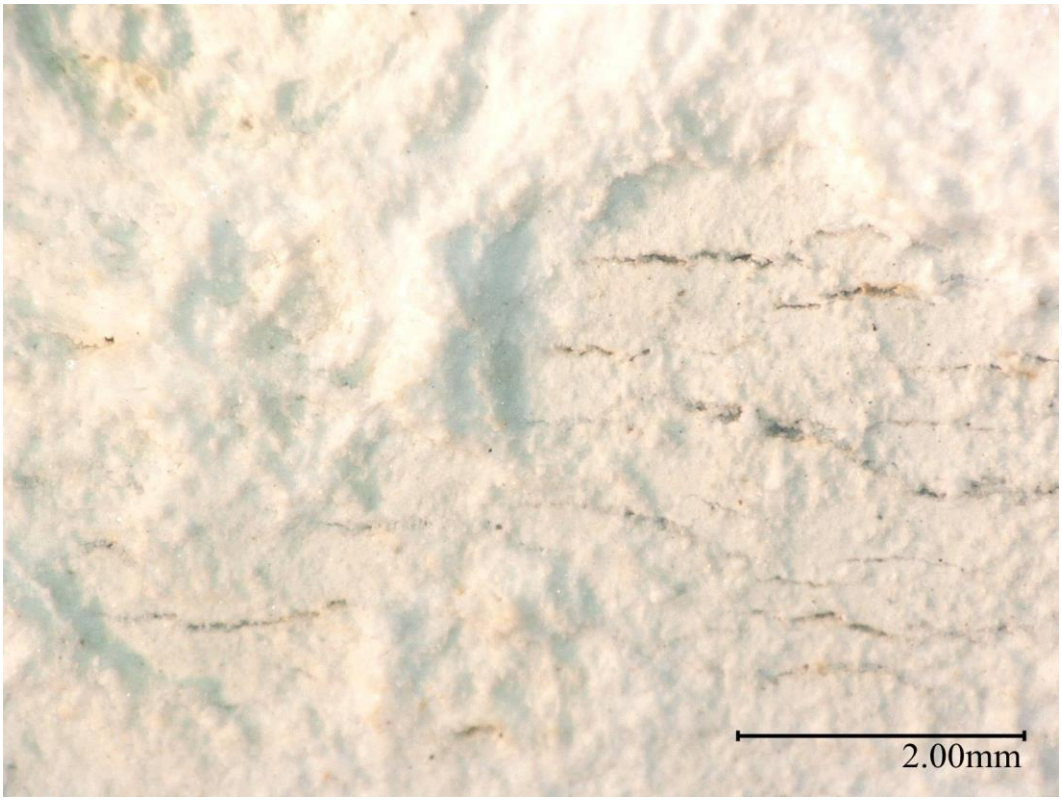


(b) Sample B-2, Box in (a) 50X

Figure 28 Digital microscope images of Sample B-2 after a bend test and salt spray.

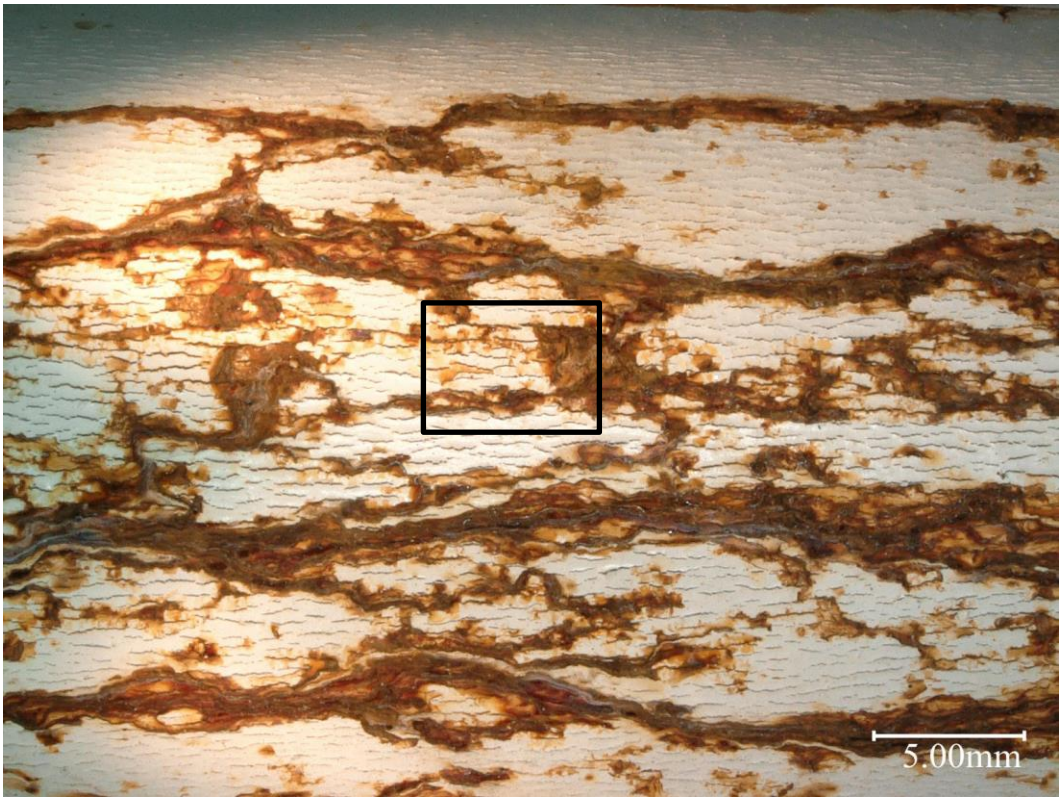


(a) Sample C-2 10X

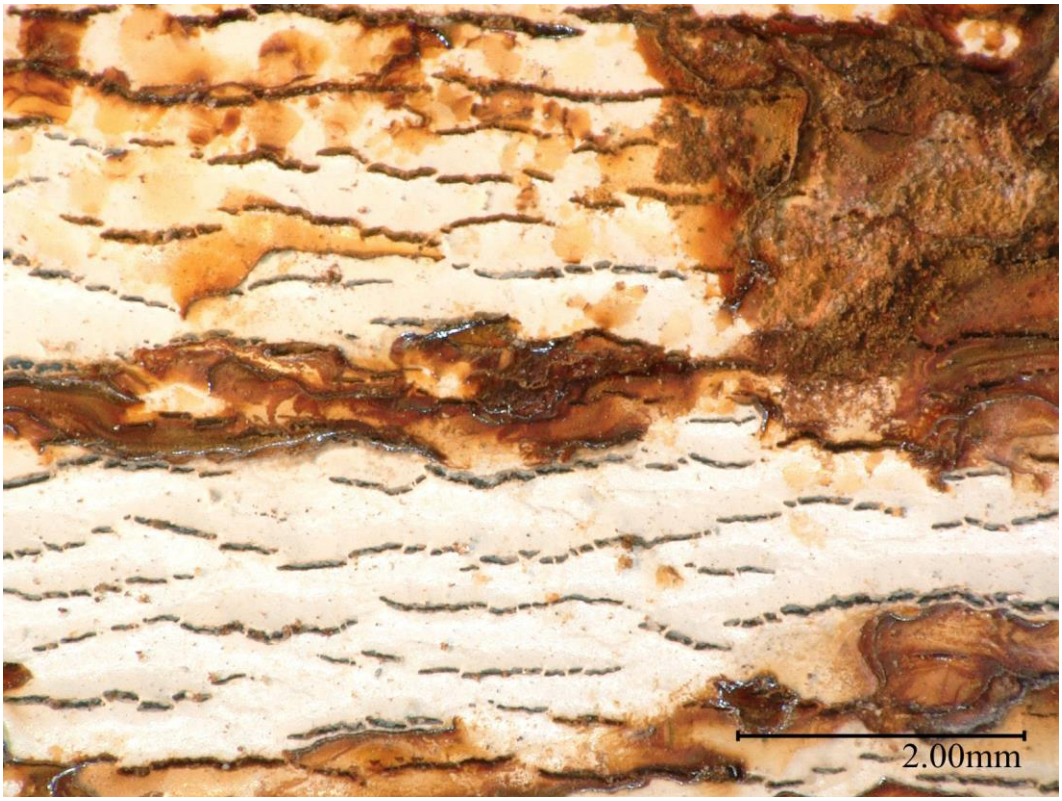


(b) Sample C-2, Box in (a) 50X

Figure 29 Digital microscope images of Sample C-2 after a bend test and salt spray.

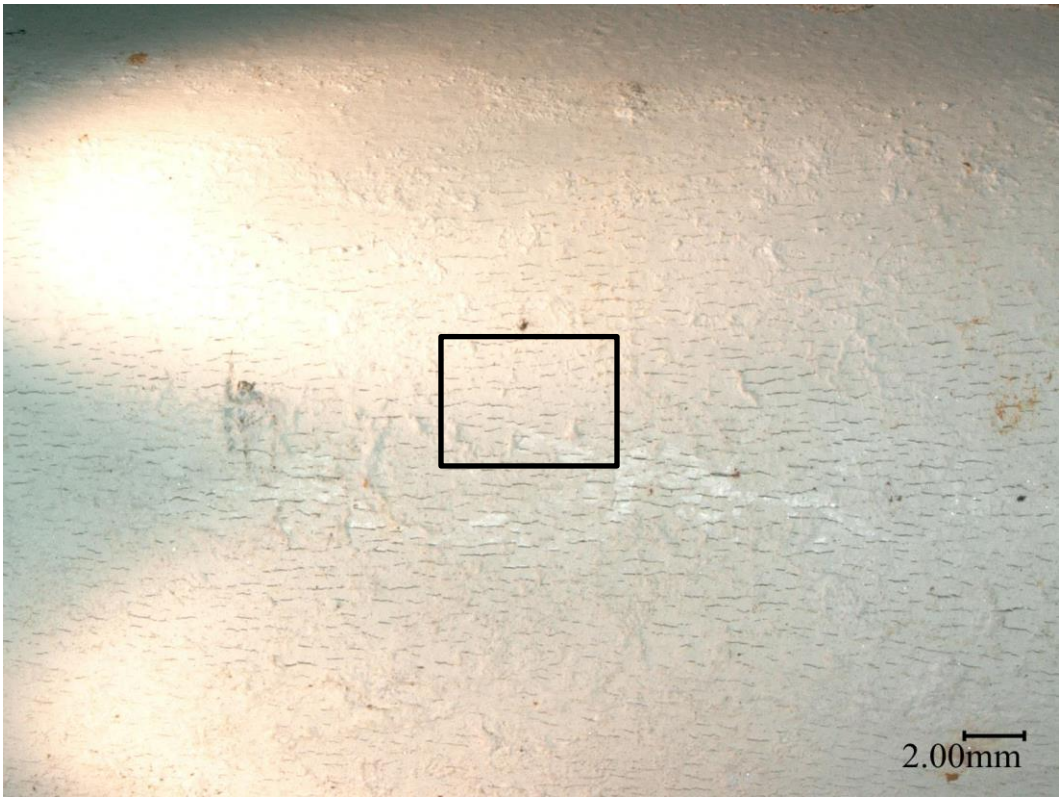


(a) Sample D-2 10X

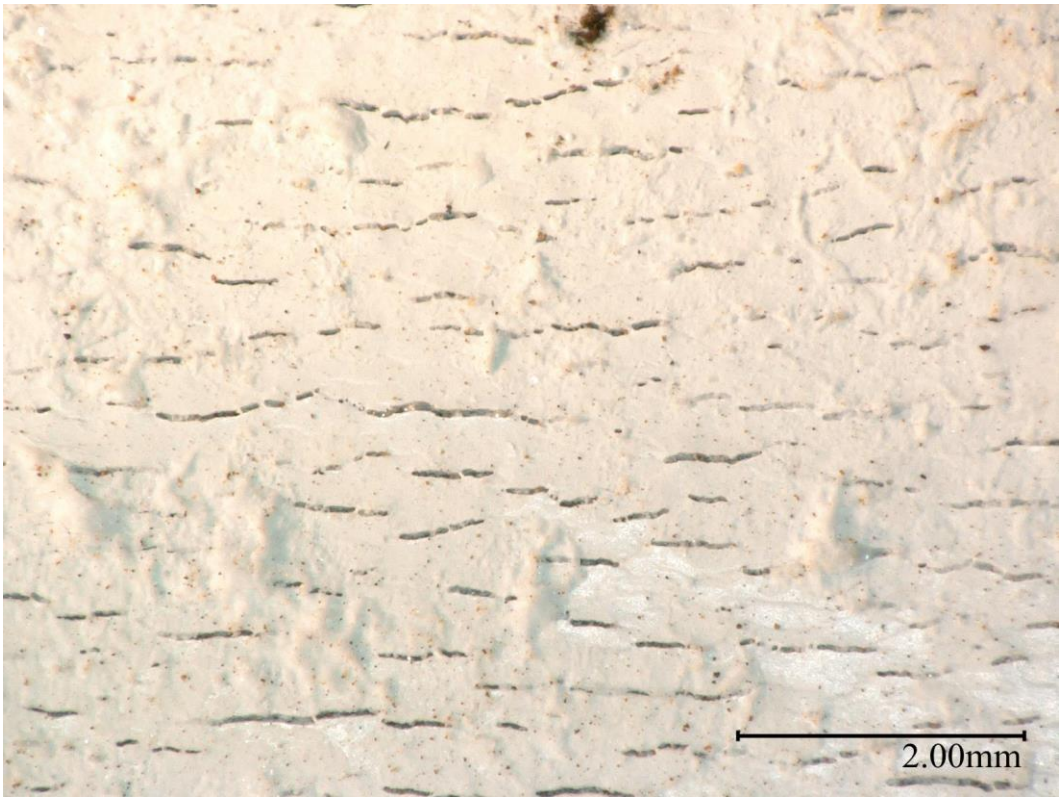


(b) Sample D-2, Box in (a) 50X

Figure 30 Digital microscope images of Sample D-2 after a bend test and salt spray.

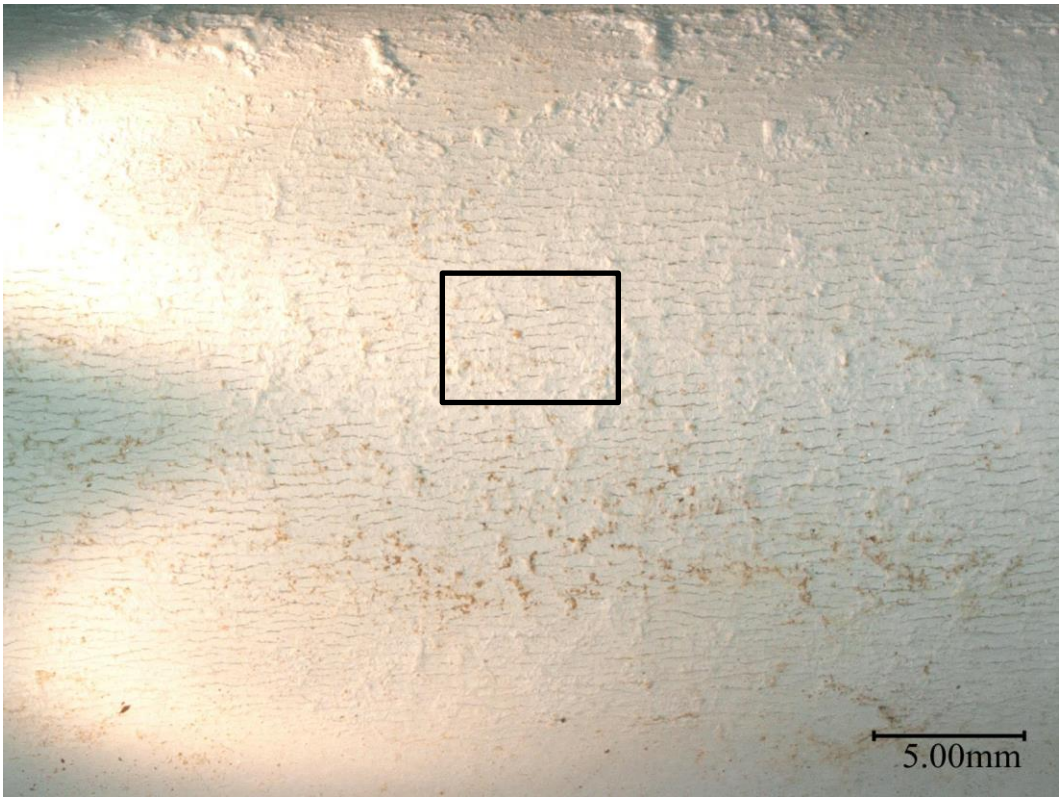


(a) Sample E-2 10X

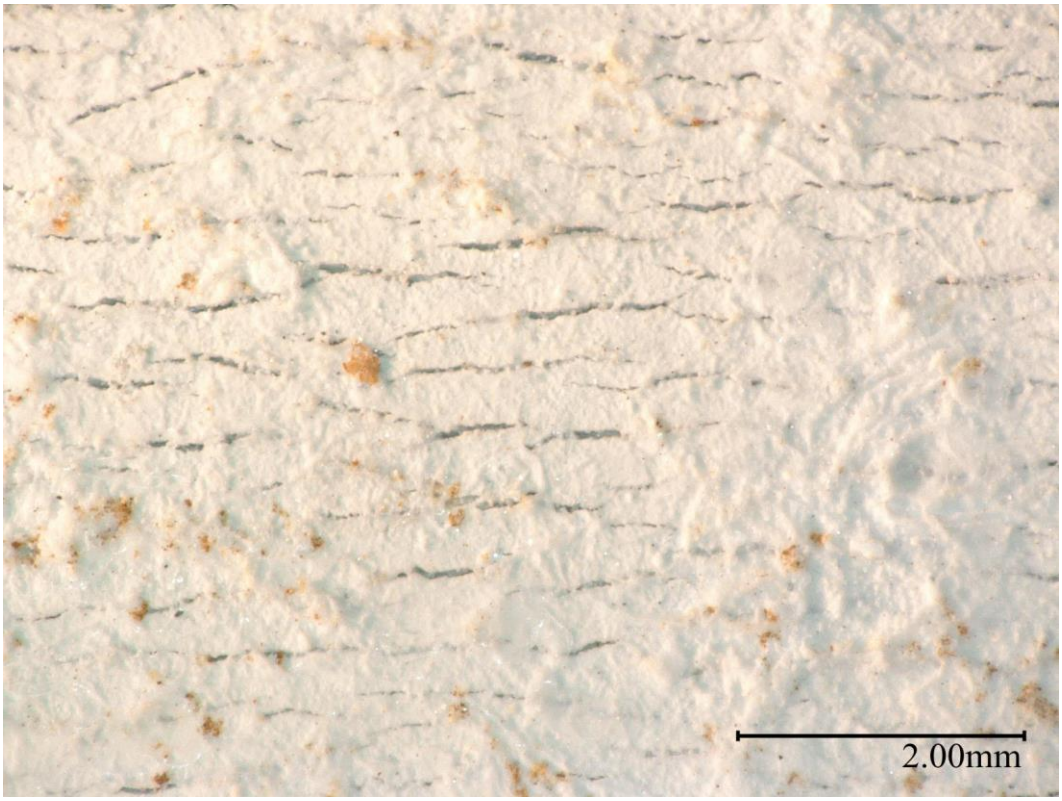


(b) Sample E-2, Box in (a) 50X

Figure 31 Digital microscope images of Sample E-2 after a bend test and salt spray.

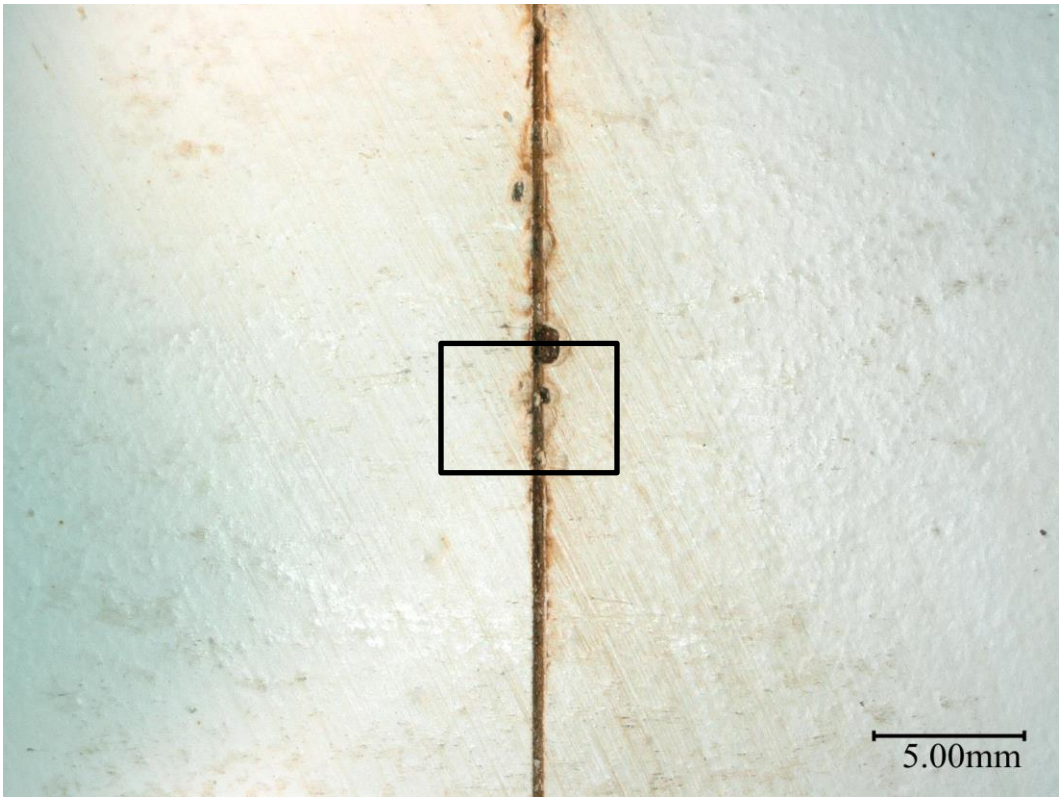


(a) Sample F-2 10X

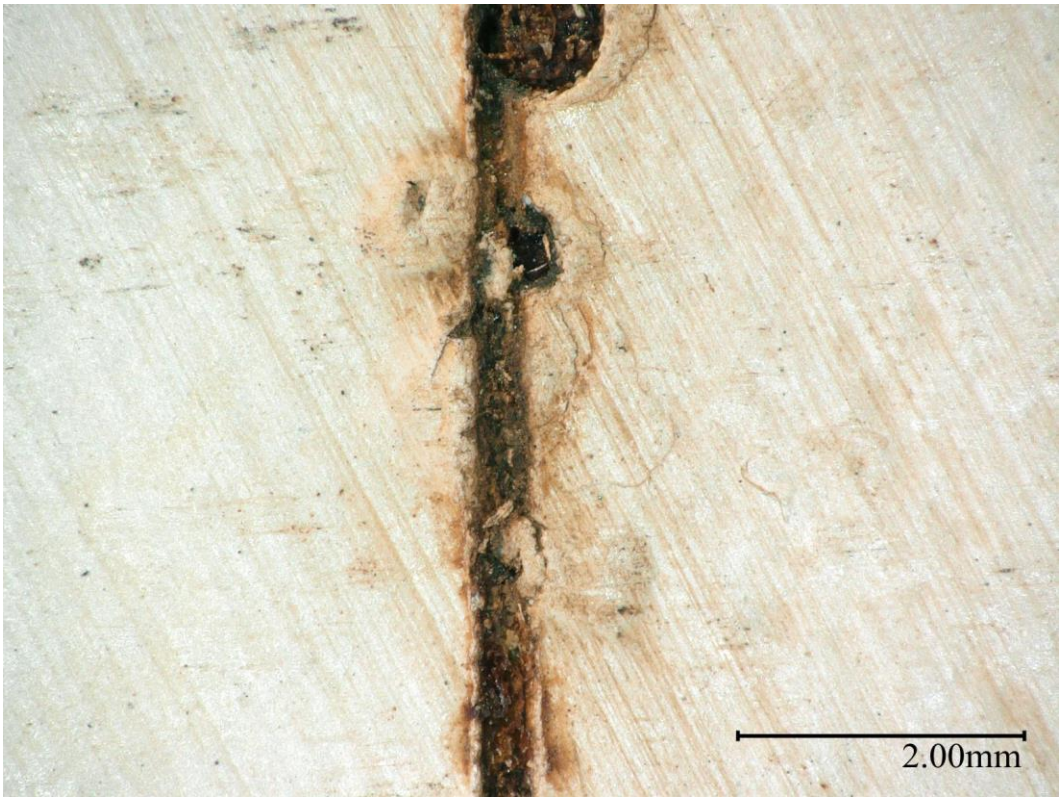


(b) Sample F-2, Box in (a) 50X

Figure 32 Digital microscope images of Sample F-2 after a bend test and salt spray

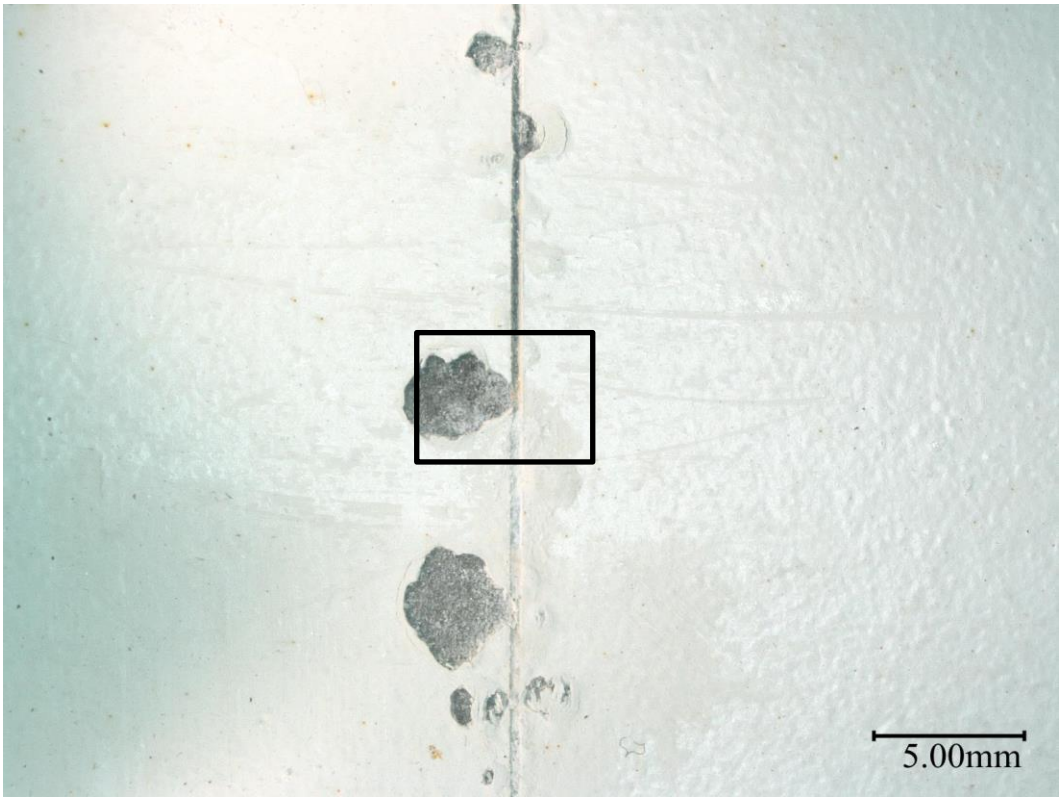


(a) Sample A-3 10X

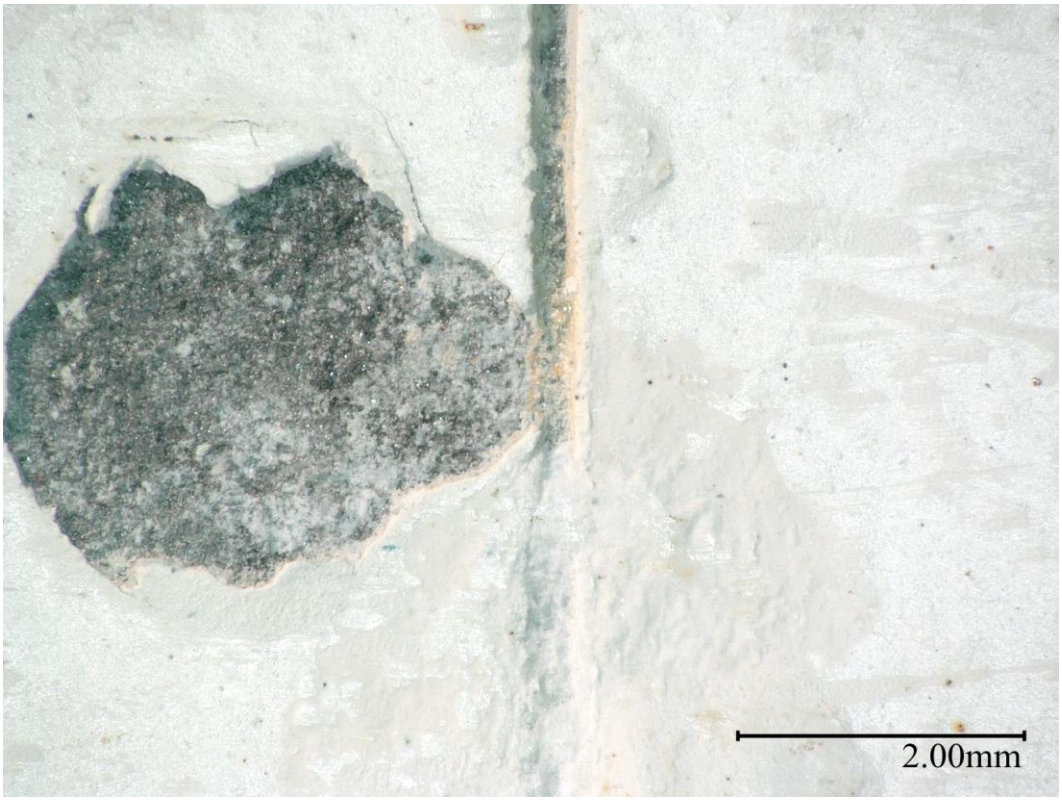


(b) Sample A-3, Box in (a) 50X

Figure 33 Digital microscope images of Sample A-3 after scribe and salt spray.

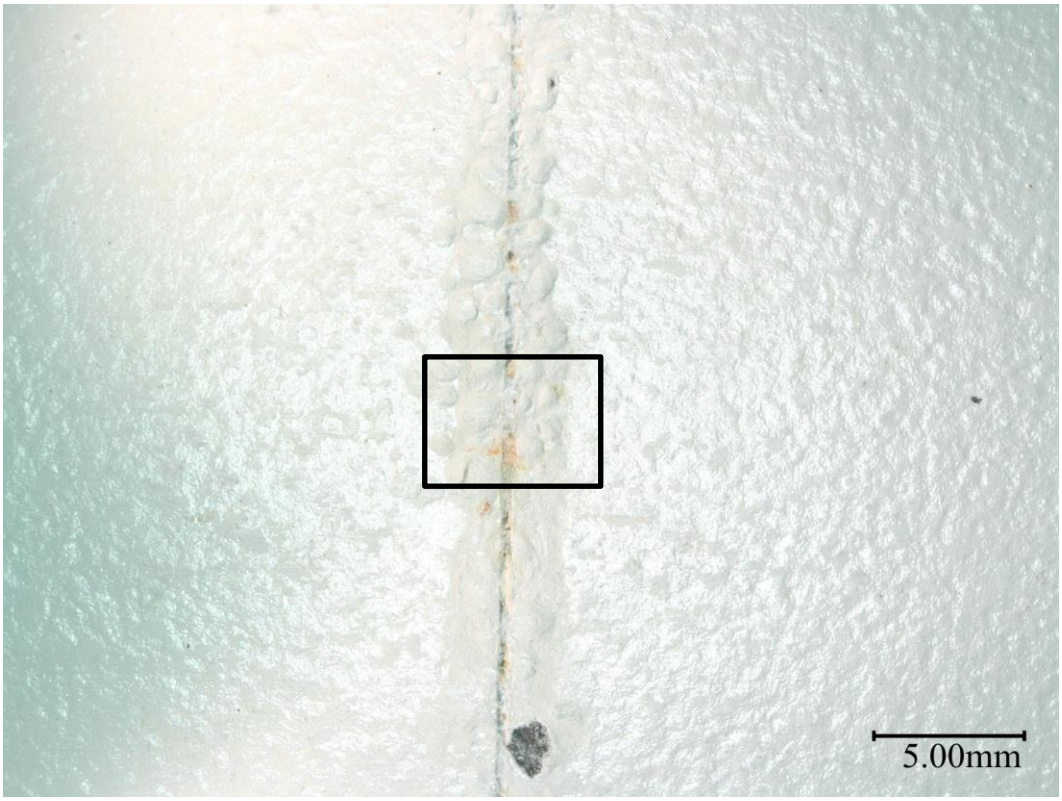


(a) Sample B-3 10X

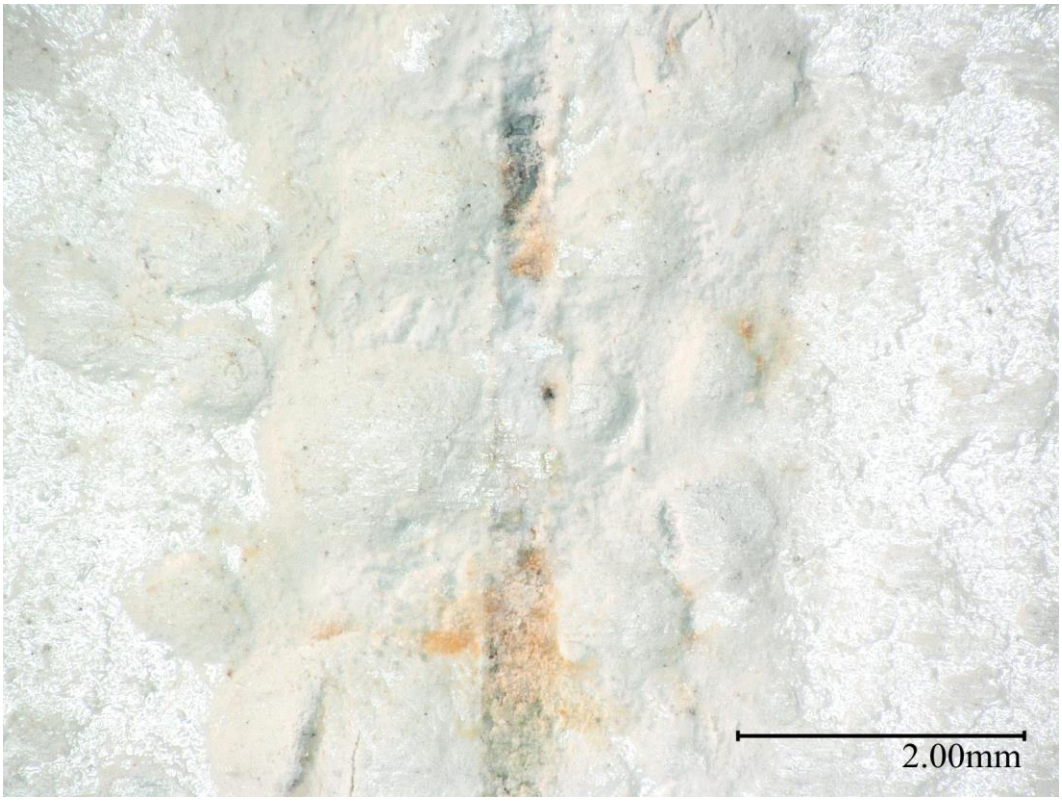


(b) Sample B-3, Box in (a) 50X

Figure 34 Digital microscope images of Sample B-3 after scribe and salt spray.

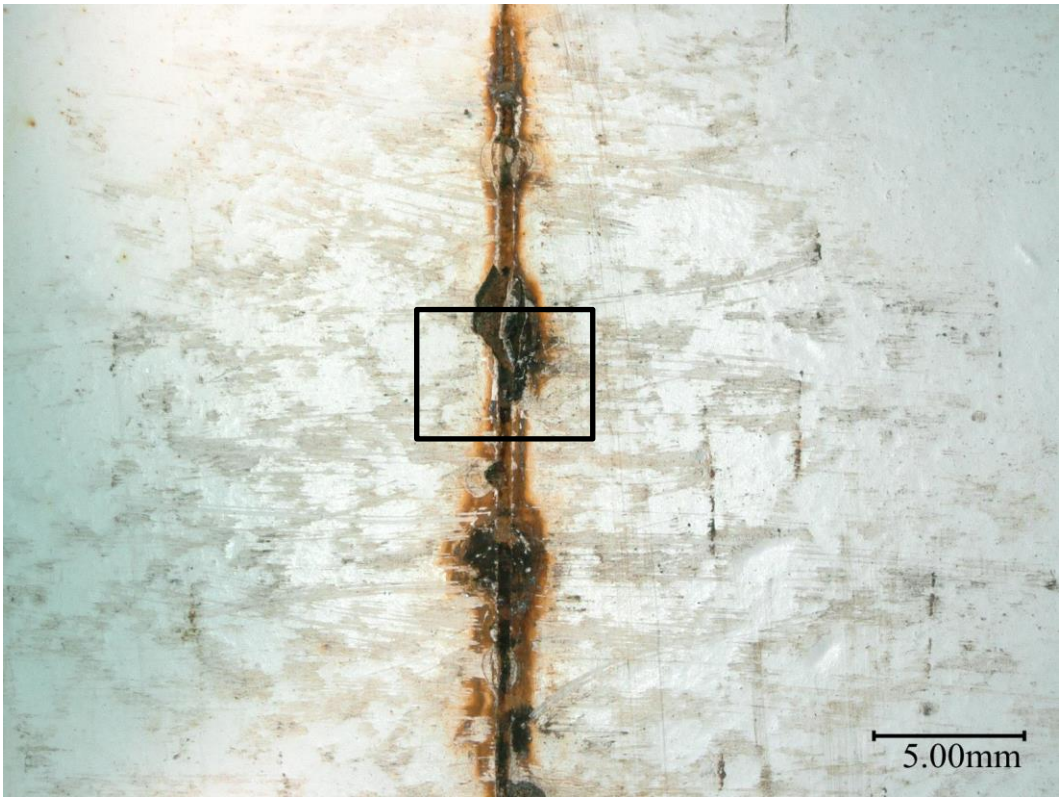


(a) Sample C-3 10X

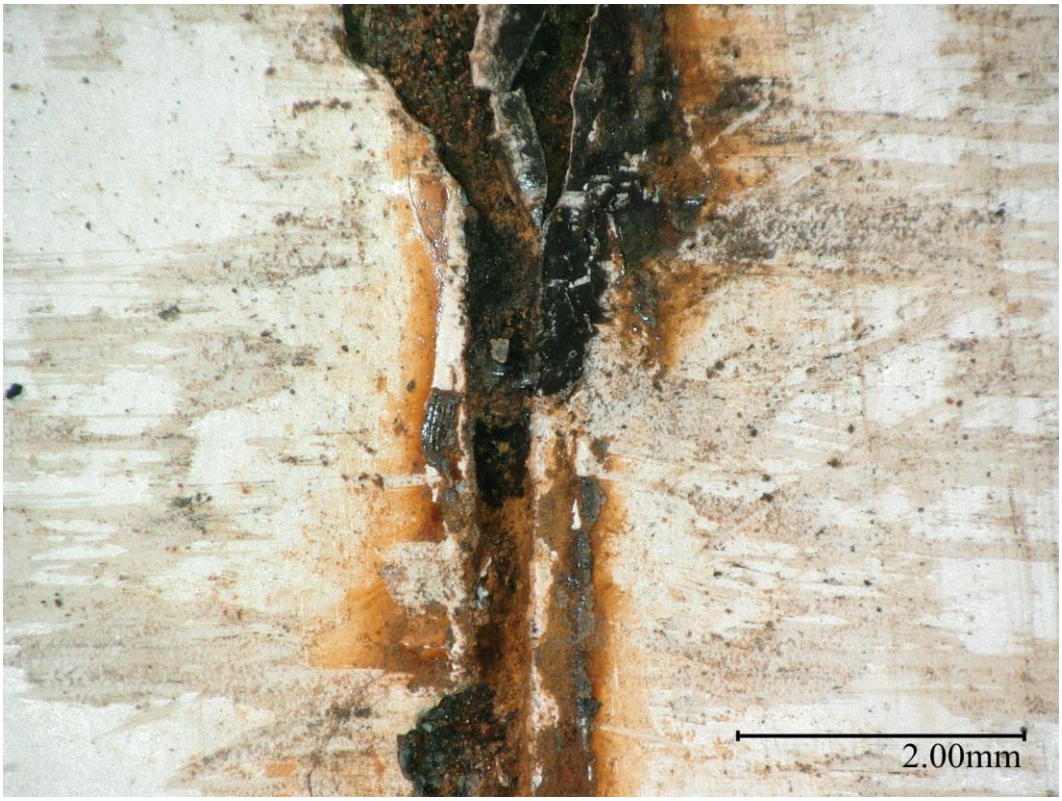


(b) Sample C-3, Box in (a) 50X

Figure 35 Digital microscope images of Sample C-3 after scribe and salt spray.

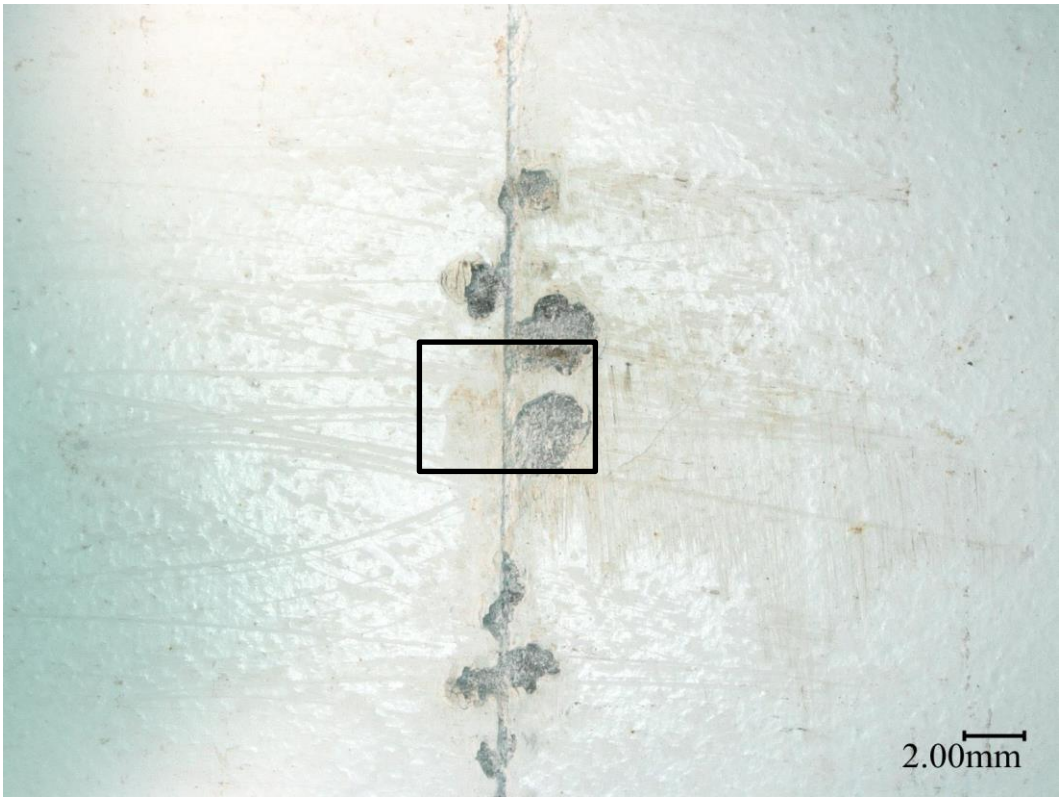


(a) Sample D-3 10X

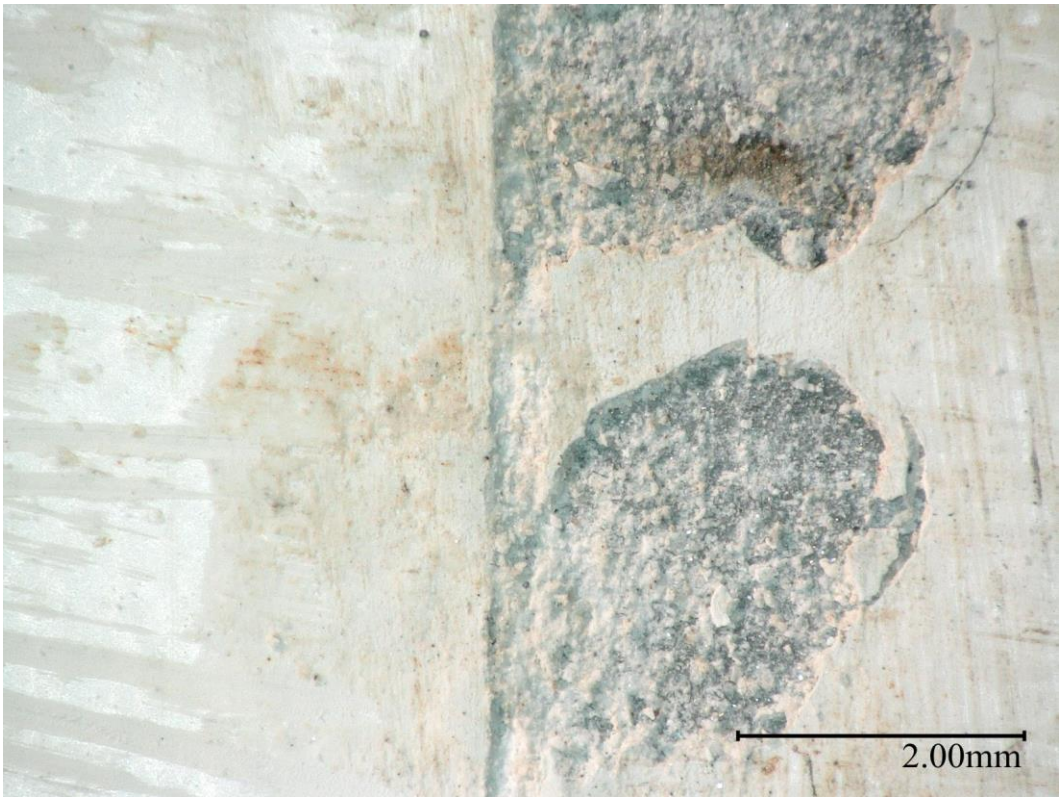


(b) Sample D-3, Box in (a) 50X

Figure 36 Digital microscope images of Sample D-3 after scribe and salt spray.

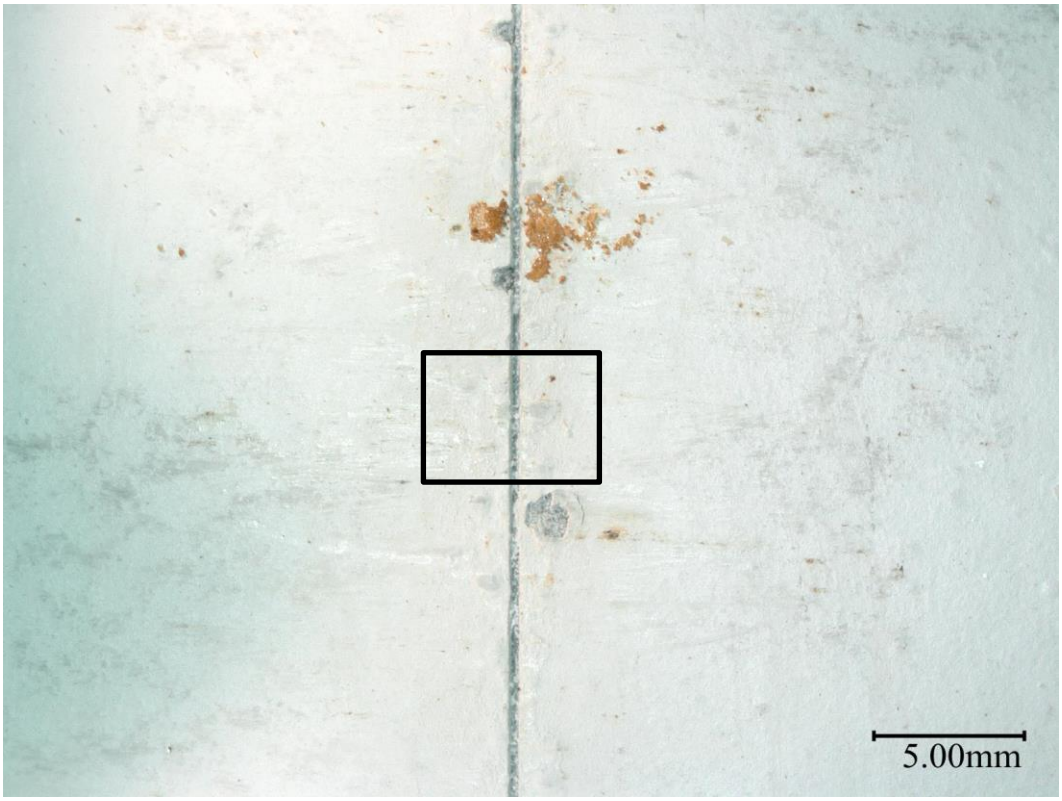


(a) Sample E-3 10X

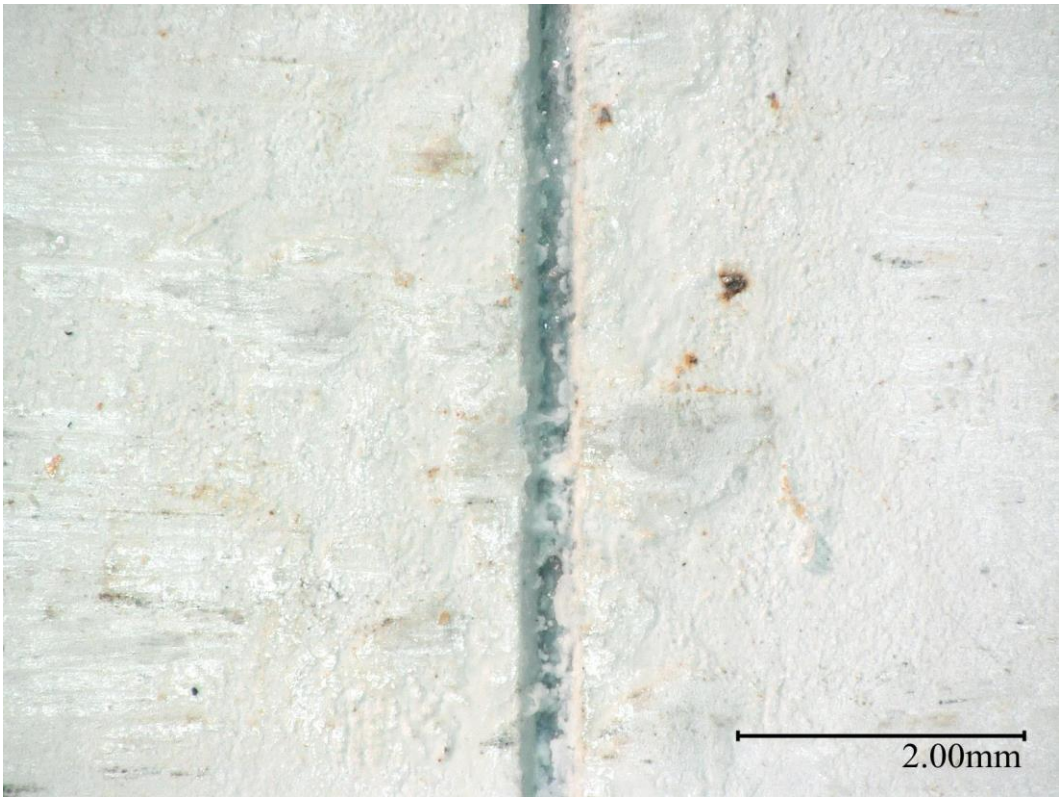


(b) Sample E-3, Box in (a) 50X

Figure 37 Digital microscope images of Sample E-3 after scribe and salt spray.

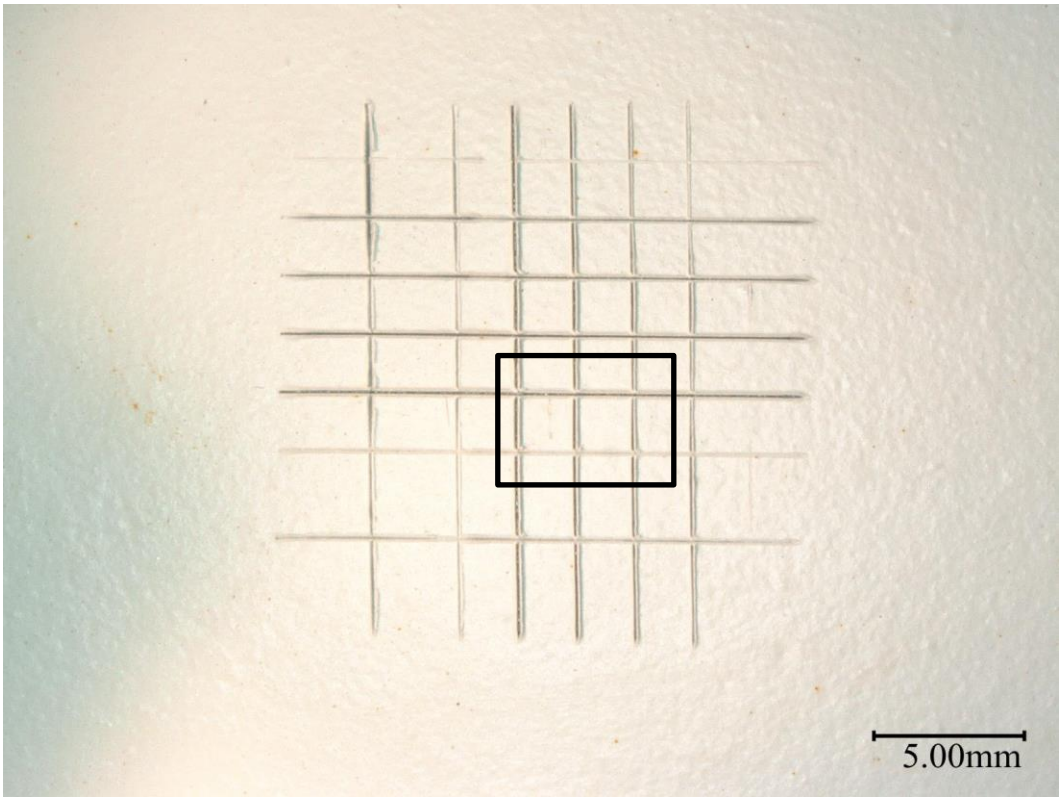


(a) Sample F-3 10X

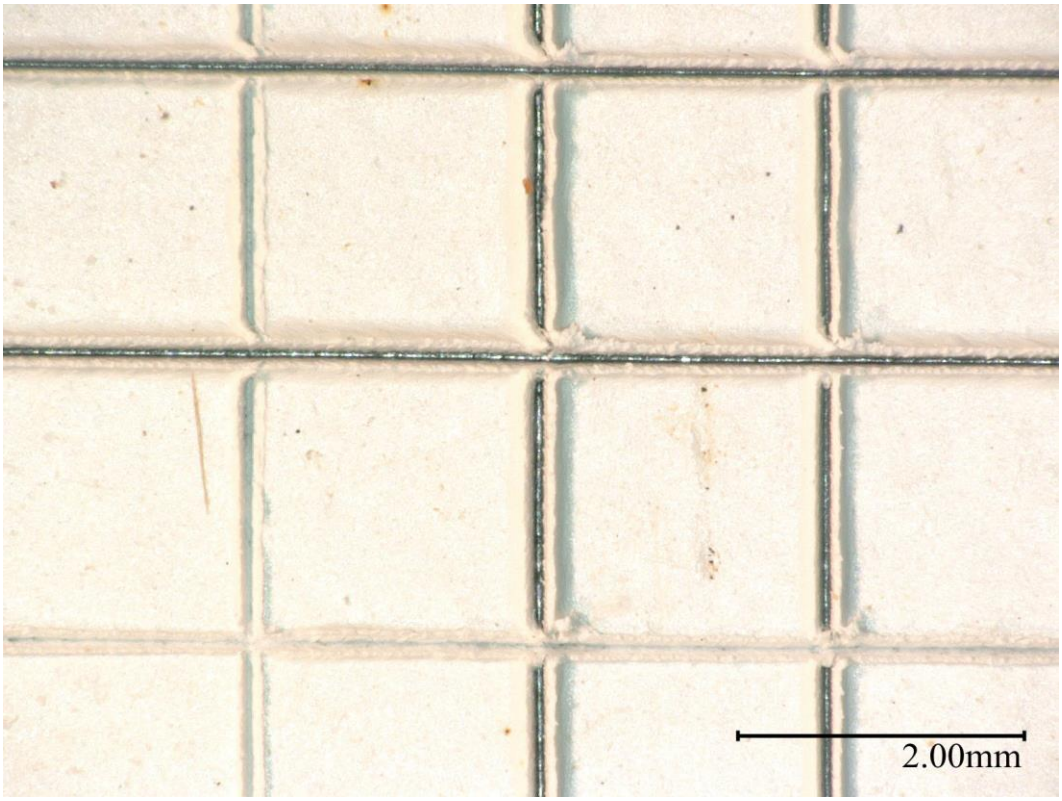


(b) Sample F-3, Box in (a) 50X

Figure 38 Digital microscope images of Sample F-3 after scribe and salt spray.

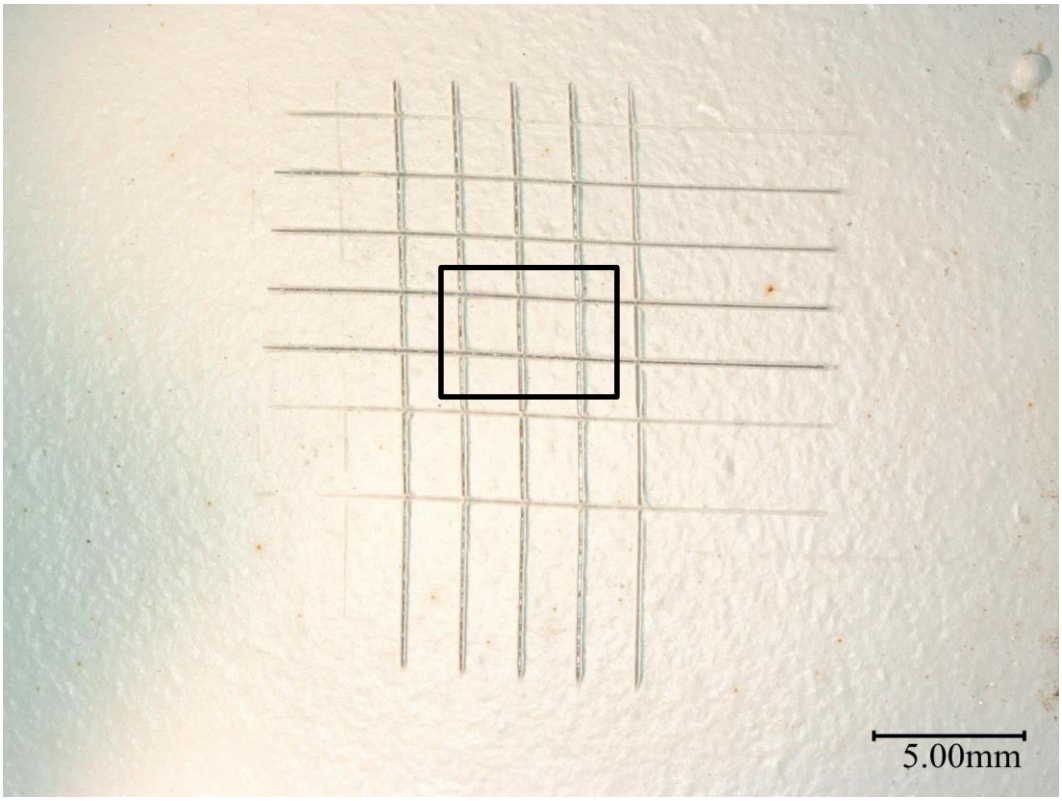


(a) Sample A-4 10X

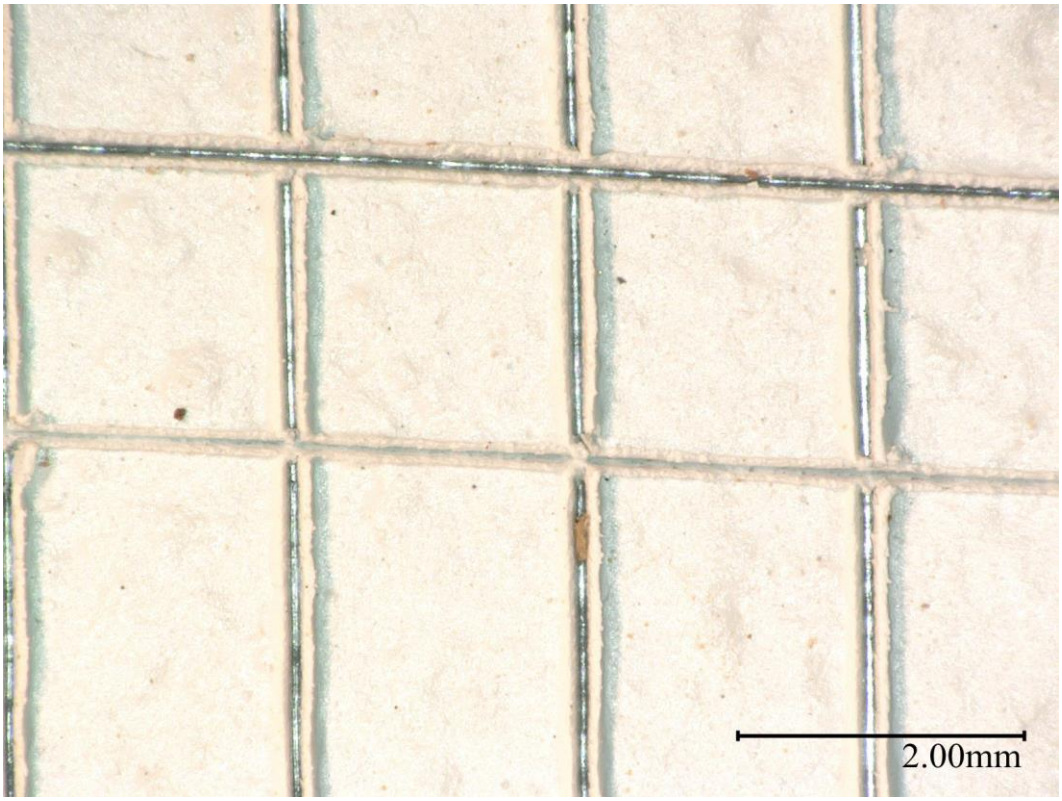


(b) Sample A-4, Box in (a) 50X

Figure 39 Digital microscope images of Sample A-4 after salt spray and adhesion.

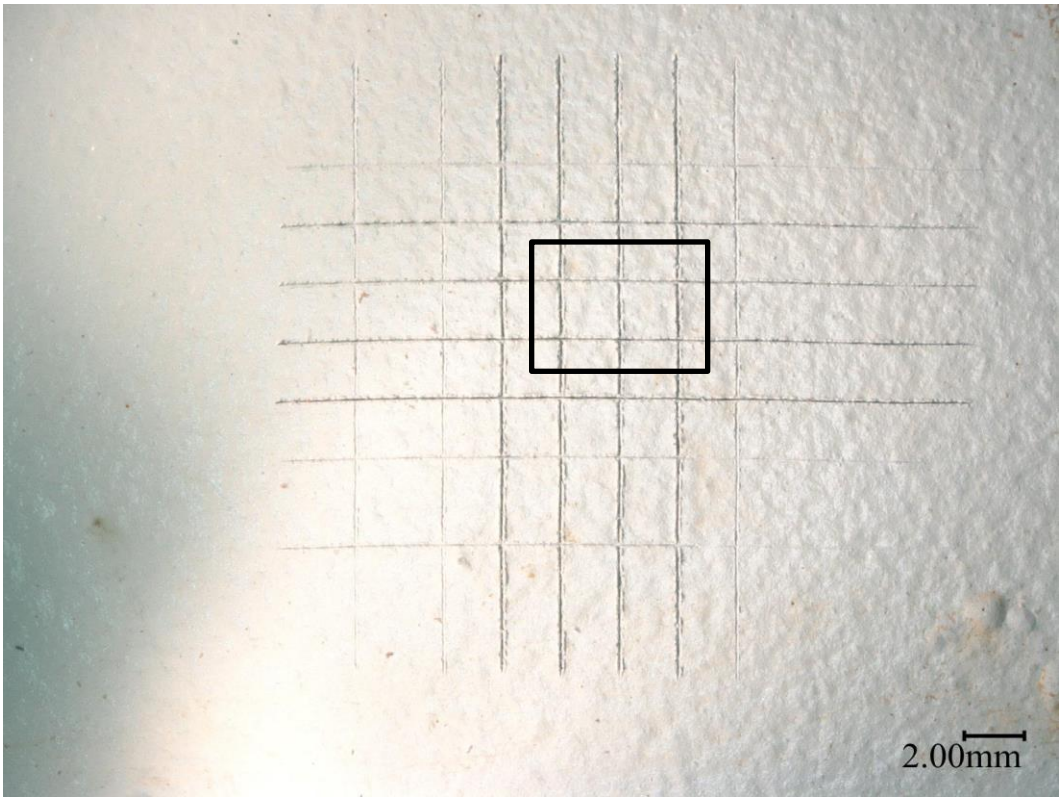


(a) Sample B-4 10X

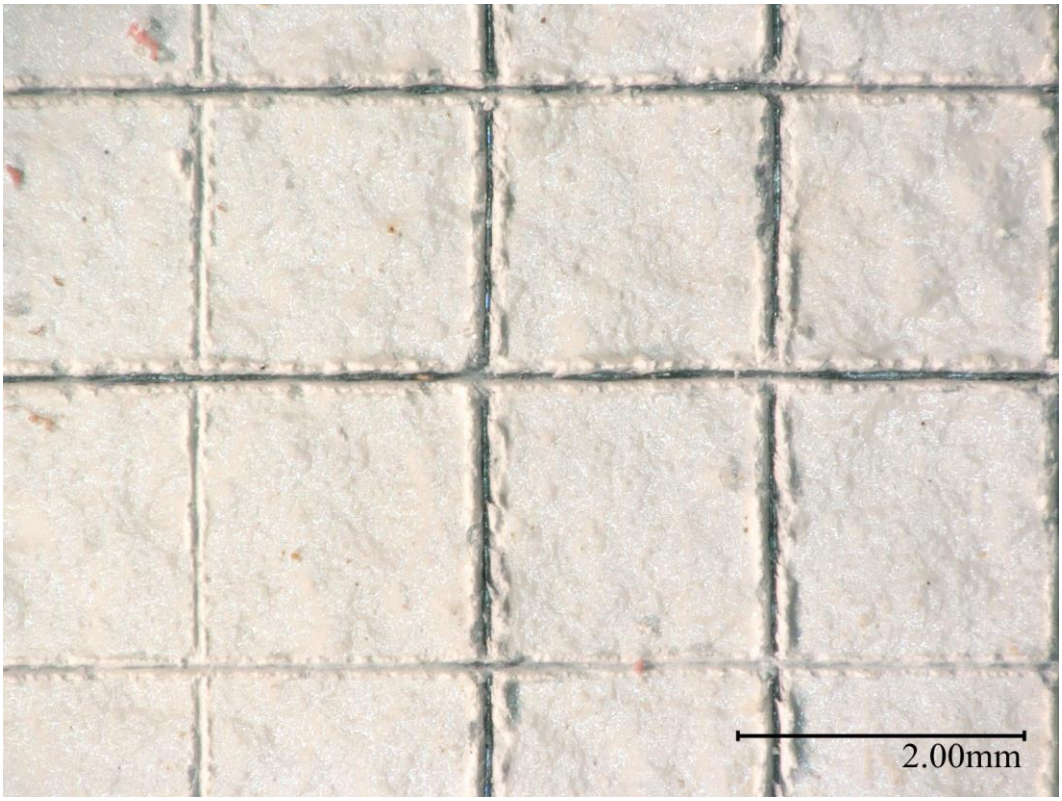


(b) Sample B-4, Box in (a) 50X

Figure 40 Digital microscope images of Sample B-4 after salt spray and adhesion.

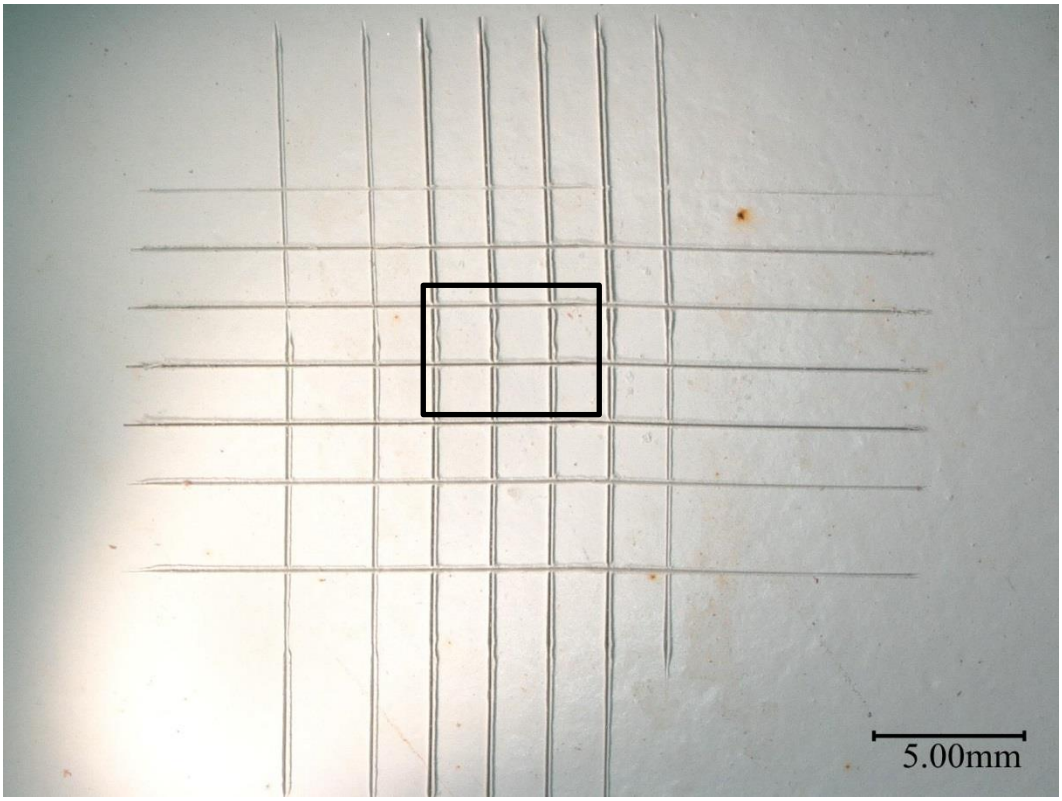


(a) Sample C-4 10X

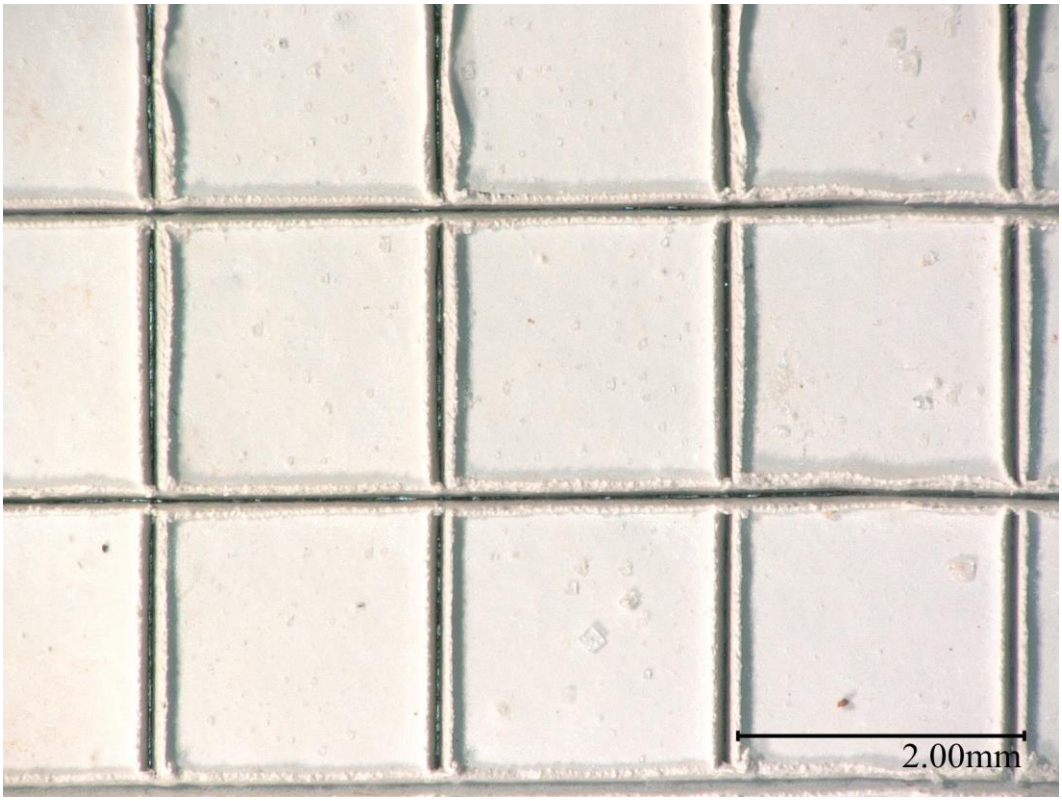


(b) Sample C-4, Box in (a) 50X

Figure 41 Digital microscope images of Sample C-4 after salt spray and adhesion.

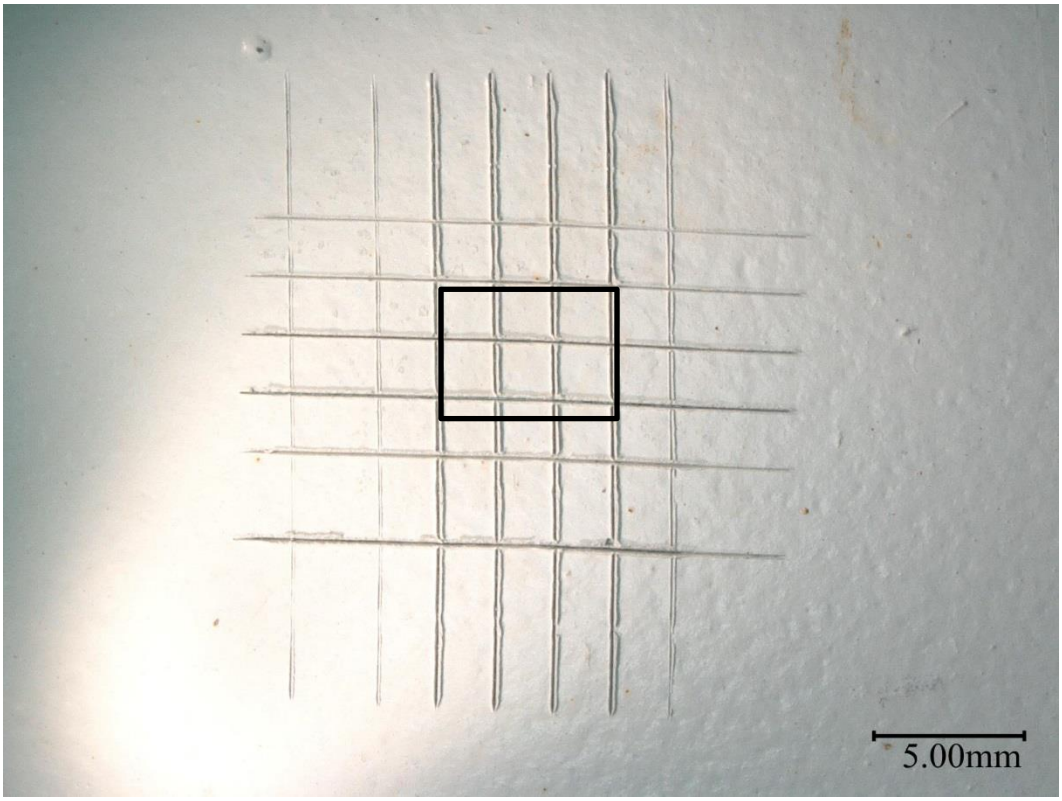


(a) Sample D-4 10X

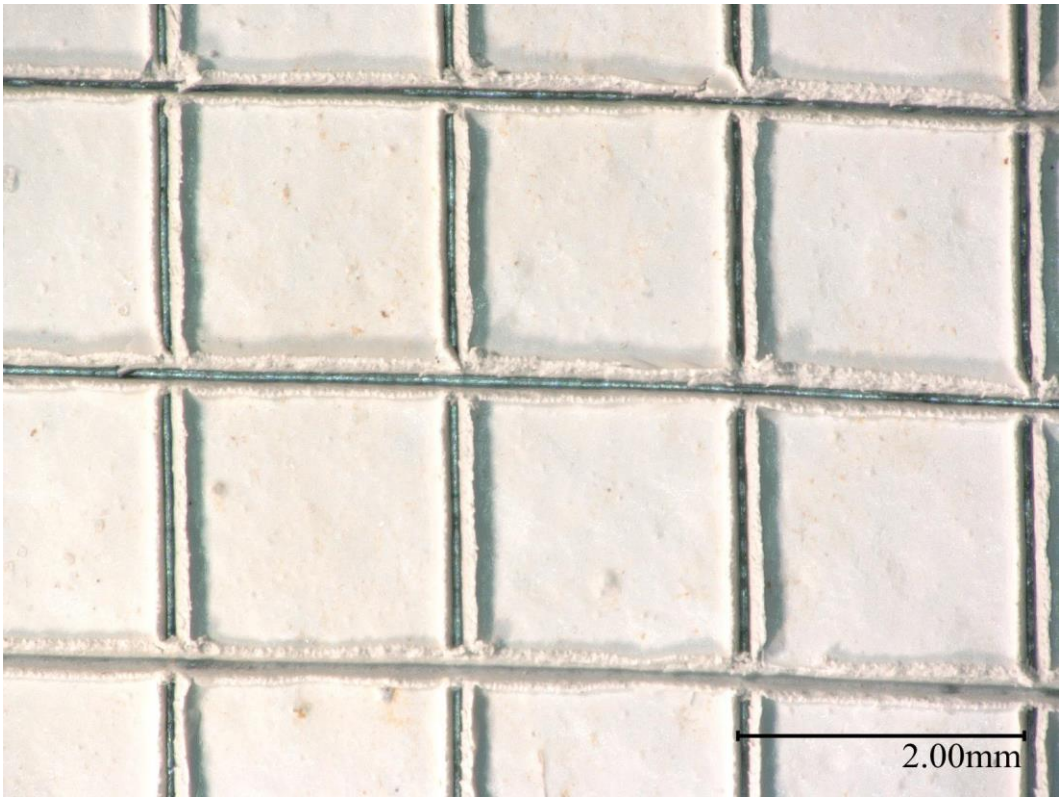


(b) Sample D-4, Box in (a) 50X

Figure 42 Digital microscope images of Sample D-4 after salt spray and adhesion.

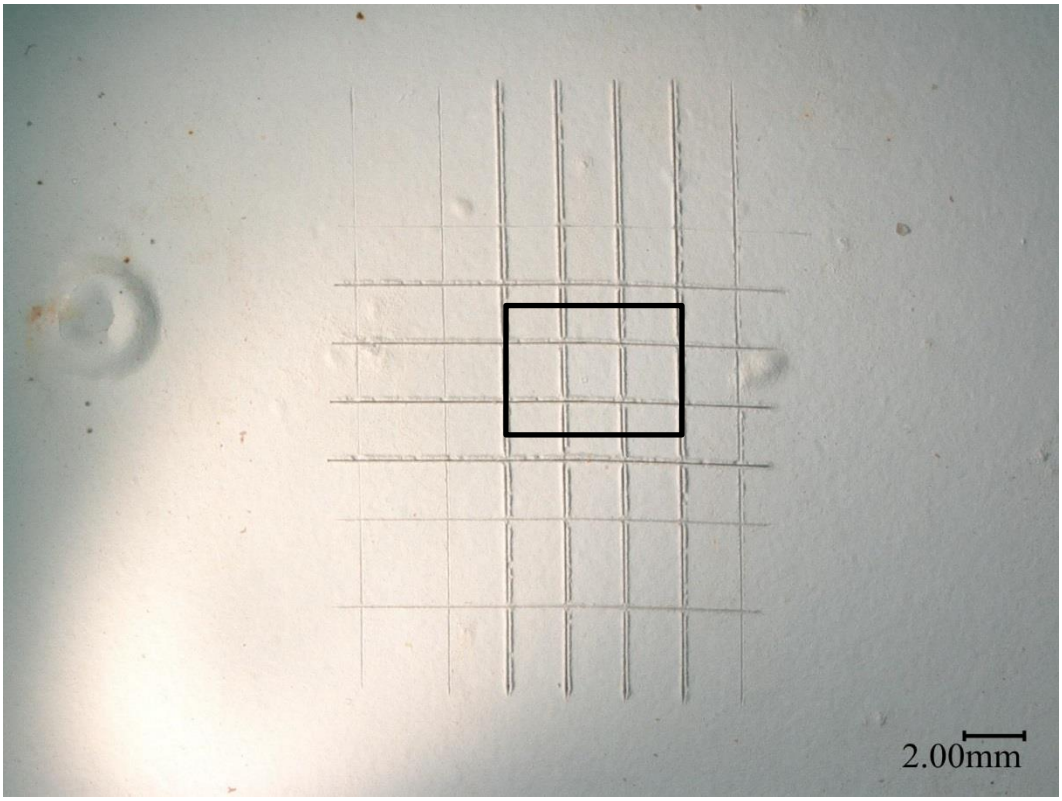


(a) Sample E-4 10X

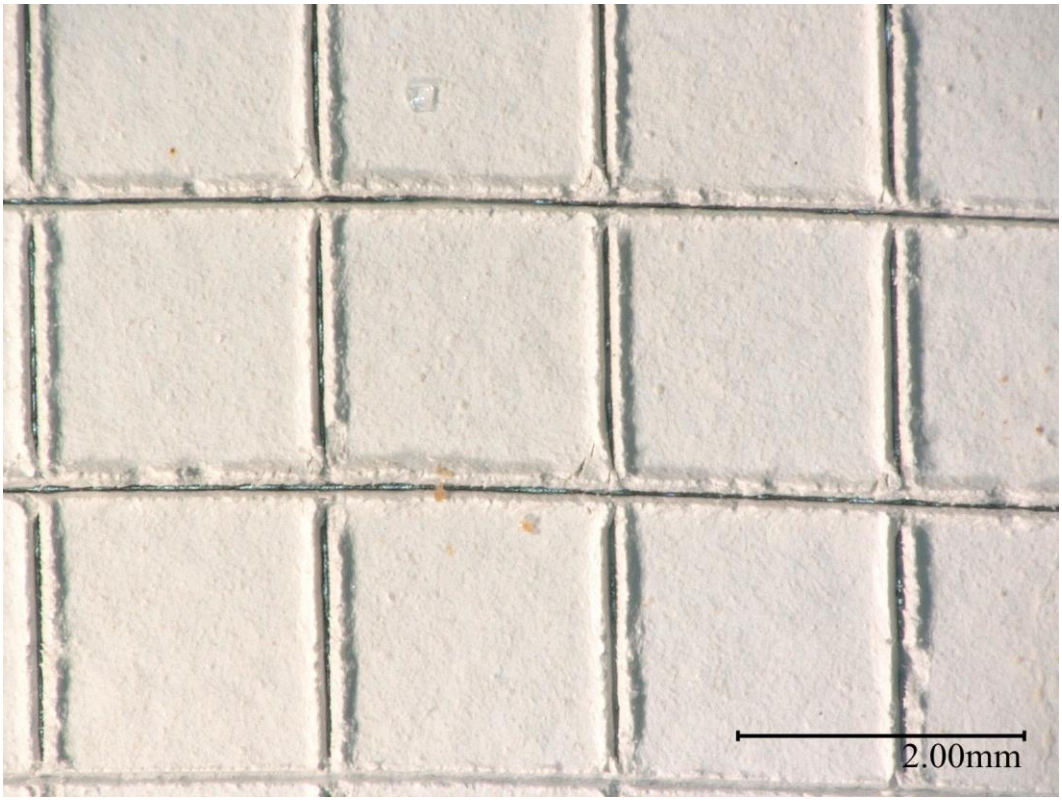


(b) Sample E-4, Box in (a) 50X

Figure 43 Digital microscope images of Sample E-4 after salt spray and adhesion.



(a) Sample F-4 10X



(b) Sample F-4, Box in (a) 50X

Figure 44 Digital microscope images of Sample F-4 after salt spray and adhesion.