



PROtection & Conservation
of Heritage airCRAFT



UNIVERSITÀ
DEGLI STUDI
DI FERRARA
- EX LABORE FRUCTUS -



UNIFE Research Unit - PI2 -

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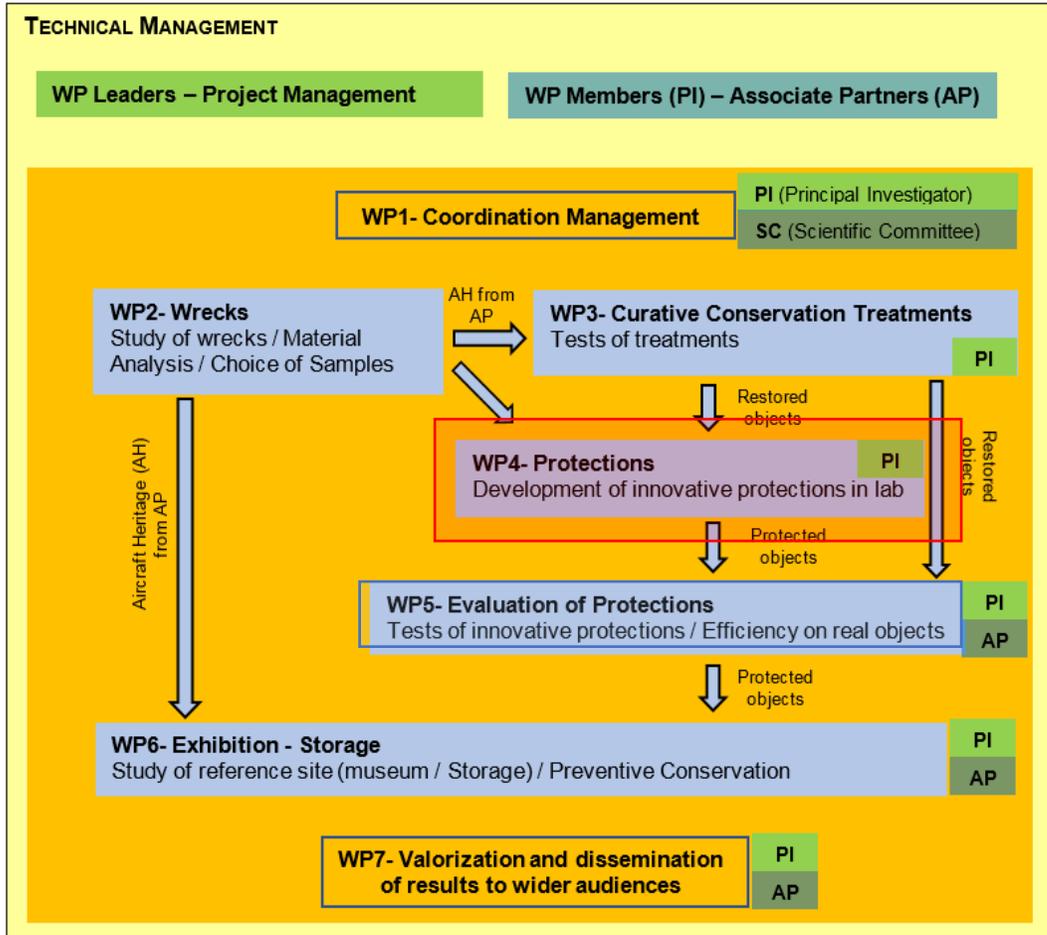
Nantes/Toulouse/Prague/Bologna/Ferrara,

Virtual Kickoff Meeting, 5 November 2020



DE Department of
Engineering
Ferrara

Activities planned in Procraft



WP4 Protection Part I - Development of protective coating for outdoor exposure

WP Leader: UNIFE;

Objectives:

- *Development of innovative protective coatings*
- *Implementation of a smart inhibitor release in the coatings*
- *Laboratory evaluation of coating performances*

RU:

- UNIBO
- CEMES
- CTU
- PAs



Activities planned in Procraft: WP4 tasks

Month 6 (April 2021) – Month 30 March 2023)

➤ Task 4.1: Selection of protective coatings

Development of innovative protective coatings for the selected substrates (WP2-3):

✓ *two modern Al alloys: one wrought and one cast, (selected in M2.1) and*

✓ *one restored original painted substrate.*

Selection of effective inhibitors

➤ Task 4.2: Implementation of a smart inhibitor delivery

Improvement protectiveness of the selected coatings smart inhibitor delivery: embedding of the inhibitor-containing carriers in the selected coatings.

➤ Task 4.3: Tests of different protective coatings

Evaluation of the coating's performances by electrochemical measurements (PPC and EIS): short and long exposures to ARX10. Test for inhibitor release on cross-cut coated specimens during exposures to acidic rain spray fog test.



Activities planned in Procraft: UNIFE in WP5

WP5: Protection Part II – Protective Coating Assessment (from M20 to M36)

WP Leader: UNIBO;

PIs: UNIFE, AA, CEMES, CTU; Associate Partners

Objectives:

- - *Evaluation of effective protection of the innovative protective coatings on original substrates through accelerated ageing tests;*
- - *Identification of advantages and limits of innovative protection;*
- - *Comparison between innovative and traditional protective coatings.*

Task 5.1: Application of protective coatings on selected substrates and pre-exposure characterization

Task Leader: UNIBO

Application of the **best performing protective coatings from WP4**, by conservators (PI1) on the original substrates (selected in WP3), *according to CR best practices*, with careful monitoring, so as to assess *the conformity of treated surfaces to CH requirements*.



Activities planned in Procraft

| Project phase / Duration of the project (in months) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | |
|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|------|------|------|----|----|----|----|----|----|----|----|------|----|----|----|----|------|------|
| WP4 - Protection Part I - Development of protective coating for outdoor exposure (M6 – M30) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Task 4.1: Selection of protective protection | | | | | | | | | | | | | | | | | | | D4.1 | | | | | | | | | | | | | | | | | |
| Task 4.2: Implementation of a smart inhibitor delivery | | | | | | | | | | | | | | | | | | | | | D4.2 | | | | | | | | | | | | | | | |
| Task 4.3: Tests of different protective treatments | | | | | | | | | | | | | | | | | | | | M4.1 | | | | | | | | | | D4.3 | | | | | | |
| WP5 - Protection Part II - Coating protective assessment (M20 – M36) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Task 5.1: Application of protective coatings on selected substrates and pre-exposure characterization | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Task 5.2: Exposure of treated samples to accelerated artificial ageing in outdoor and semi-confined conditions | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Task 5.3: Characterization of aged surfaces (post-exposure) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | D5.1 | |
| Task 5.4: Comparison of the best innovative protection and the classical protections used in conservation-restoration | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | D5.2 |

WP4: Month 6 (April 2021) – Month 30 March 2023)

Deliverables and Milestones

- **D4.1 (M18 April 2022) Protection efficiency report for developed coatings on modern alloys**
- **D4.2 (M20 June 2022) Protection efficiency report for developed coatings on original painted alloys**
- **M4.1 (M20) Proposal of candidate protection systems for bare and painted Al substrates (to be further tested in WP5)**
- **D4.3 (M30) Characterization report for developed coatings**

Activities planned in Procraft: substrates

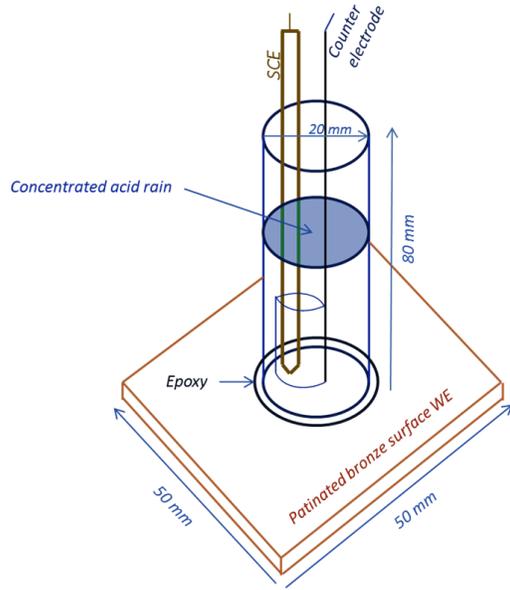
Substrates from WP2-3

- *Two modern Al alloys for preliminar lab test (M2.1 Month 6): one wrought and one cast: up to 5wt% Cu (?) Possible candidates (wrought): AA2014, Cast (?)*
- *Restored original painted substrate (M3.1):*



Activities planned in Procraft: test protocol

Electrochemical measurements



EIS measurement:

E_{cor} , 10 mV rms sinusoidal perturbation;
65 kHz - 1 mHz;
5-10 points / decade.

Cathodic polarization curve: start from E_{cor} to -0.25 V vs E_{cor} , then wait for E_{cor} recovery (e.g. 1h)

Anodic polarization curve: from E_{cor} to 0.5 V vs E_{cor} .
Potentiodynamic scan rate 0.167 mV/s.

All potentials will be referred to the SCE scale

Test solution

| Conc. acid rain (ARX10) | |
|---|--------------------------|
| Conductivity (RT) | 360 μScm^{-1} |
| pH | 3.3 |
| $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ | 14.4 mgL^{-1} |
| $(\text{NH}_4)_2\text{SO}_4$ | 15.0 mgL^{-1} |
| NH_4Cl | 19.1 mgL^{-1} |
| NaNO_3 | 1.51 mgL^{-1} |
| HNO_3 (65 wt%) | 39.3 $\mu\text{L/L}$ |
| CH_3COONa | 3.19 mgL^{-1} |
| HCOONa | 0.8 mgL^{-1} |

Flat Cell

Tube in Poly-methyl-methacrylate:

Ext. dia. 24 mm, int dia. 20 mm; Height 80 mm

Gasket: Epoxy adhesive Reference : SCE

Counter: Pt or Stainless steel net or coil

Volume: almost full tube



Activities planned in Procraft: test protocol

Electrochemical measurements

- **Screening experiments:** 1 h E_{cor} , EIS (10^{-2} Hz) 1h; **cathodic PD, Anodic PD**
- **Short term (1 day):** 1 h E_{cor} , EIS (10^{-2} Hz) 1h, EIS 2h, EIS 8h, EIS 12 h, EIS 24 h; LP3x; **PD cathodic, PD anodic**
- **Long term: 15 days,** EIS 1h, EIS 1d, EIS 3 d, EIS 1w, EIS 2 w, EIS 3w, EIS 4w; **PD cathodic, PD anodic** (pH and conductivity control, weekly solution renewal or refill)
- **Tests in duplicate and triplicate if different**

AR Spray Fog Test

- **Long term: 1 month, W&D**



Thanks for your attention!

