



PROtection & Conservation  
of Heritage airCRAFT



UNIVERSITÀ  
DEGLI STUDI  
DI FERRARA  
- EX LABORE FRUCTUS -



# UNIFE Research Unit - PI2 -

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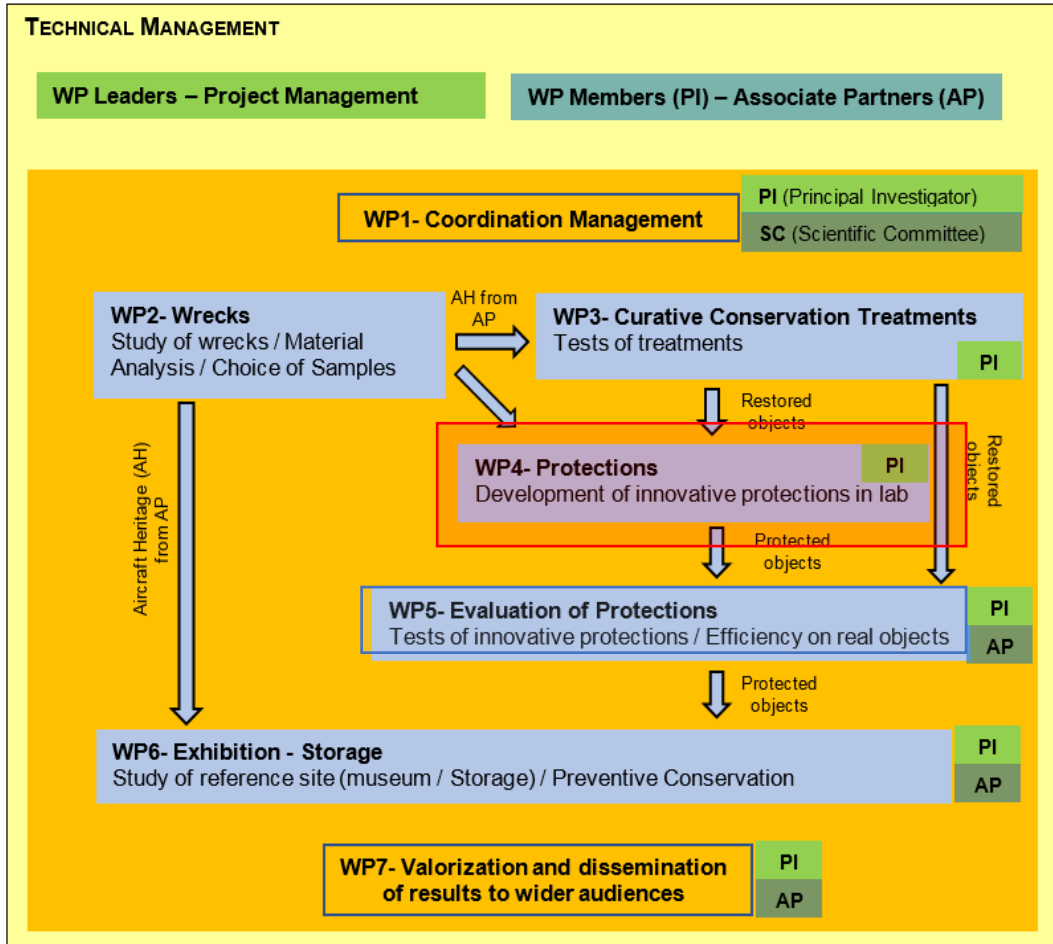
Nantes/Toulouse/Prague/Bologna/Ferrara,

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

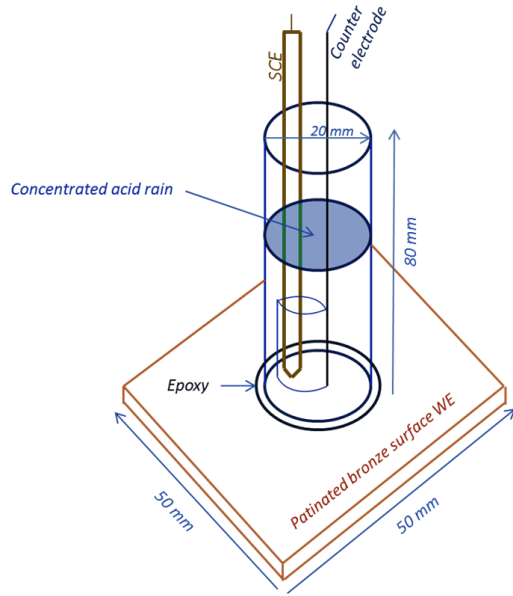
# Activities planned in Procraft: substrates

## 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



### 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

### 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 $\mu\text{Scm}^{-1}$
pH	3.3
$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	14.4 $\text{mgL}^{-1}$
$(\text{NH}_4)_2\text{SO}_4$	15.0 $\text{mgL}^{-1}$
$\text{NH}_4\text{Cl}$	19.1 $\text{mgL}^{-1}$
$\text{NaNO}_3$	1.51 $\text{mgL}^{-1}$
$\text{HNO}_3$ (65 wt%)	39.3 $\mu\text{L/L}$
$\text{CH}_3\text{COONa}$	3.19 $\text{mgL}^{-1}$
$\text{HCOONa}$	0.8 $\text{mgL}^{-1}$

# Activities planned in Procraft: test protocol

## *Electrochemical measurements*

- **Screening experiments:** 1 h  $E_{\text{cor}}$ , EIS ( $10^{-2}$  Hz) 1h; **cathodic PD, Anodic PD**
- **Short term (1 day):** 1 h  $E_{\text{cor}}$ , 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!

