Corrosion-resistant soybean extract containing fluoropolymer coatings

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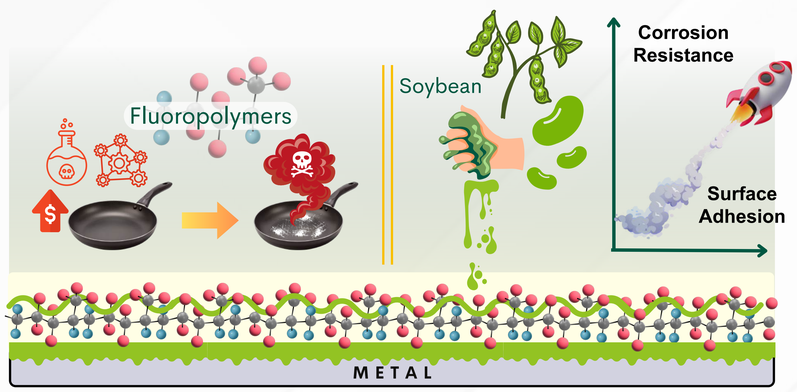
Research Statement

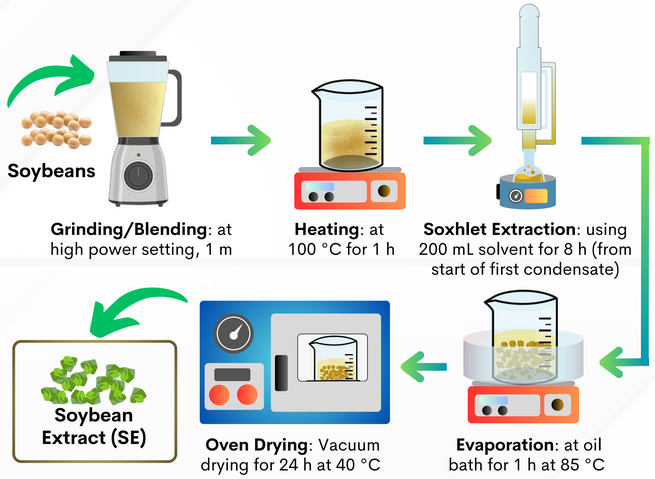
The novelty and specific strategies of the work

Introducing a new method to **enhance adhesion and corrosion protection** of fluoropolymer coatings by adding soybean extract (SE) to PVDF-HFP coatings.



Methodology

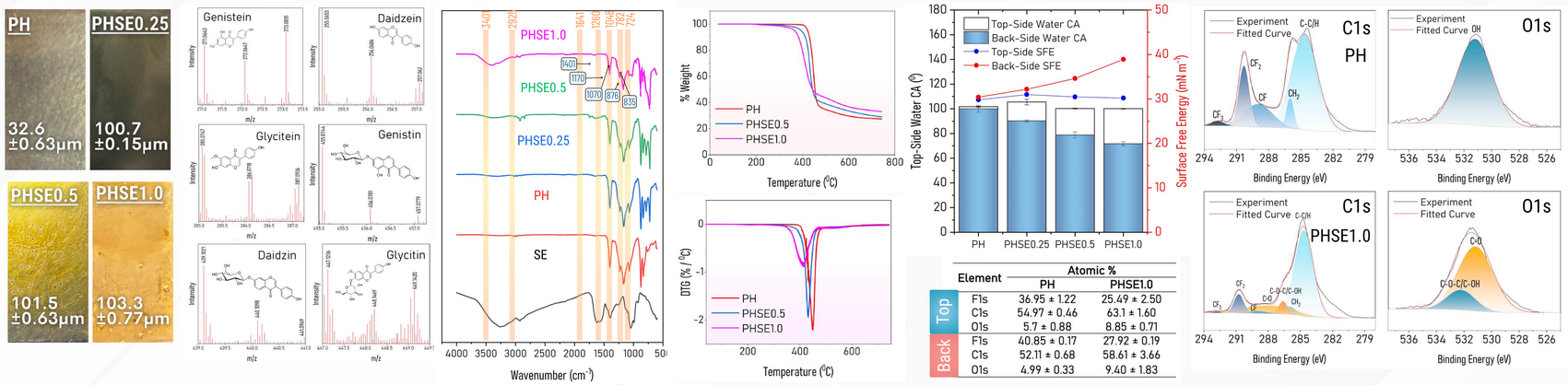
The preparation of the coating system



Carbon steel (CS) substrates were prepared by grinding with SiC grit papers, degreased, and coated with **PVDF-HFP solutions of varying SE concentrations** using a **dip coater**.

Results and Discussion

Investigating the influence of SE on PVDF-HFP coating performance



	Element	Atomic % PH	Atomic % PHSE1.0
Top	F1s	36.95 ± 1.22	25.49 ± 2.50
	C1s	54.97 ± 0.46	63.1 ± 1.60
	O1s	5.7 ± 0.88	8.85 ± 0.71
Back	F1s	40.85 ± 0.17	27.92 ± 0.19
	C1s	52.11 ± 0.68	58.61 ± 3.66
	O1s	4.99 ± 0.33	9.40 ± 1.83

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- Qualitative difference of color due to the amount of SE
- **MALDI Mass Spectrometry and ATR FTIR**: Confirms the chemical structure and presence of SE isoflavones in the fluoropolymer coatings.

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- **Thermograms and derivative thermogravimetric curves**: indicate strong thermal stability
- **Minimal decrease** of merely <3.0% in onset and offset temperatures when comparing PH and PHSE0.5

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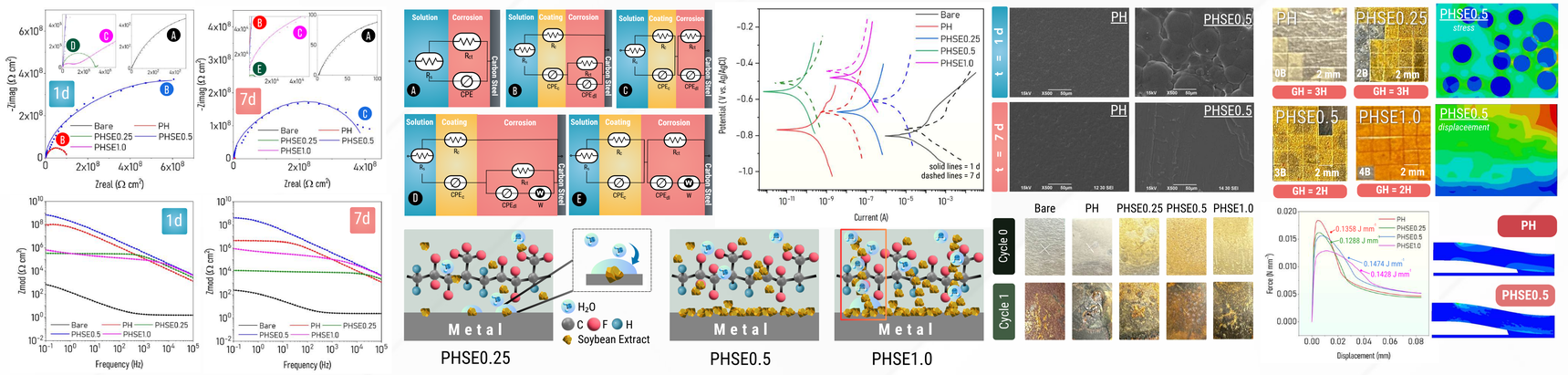
- **WCA and SFE:** Top-side PVDF-HFP dominance, while bottom-side indicates affinity of SE at the coating-metal
- **XPS:** confirms the presence of increasing SE at the bottom layer of the coating



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- **PHSE0.5**: best protection (sufficient SE) ➜ good adhesion
- **PHSE0.25**: lowest protection due to poor SE distribution ➜ poor adhesion and localized water infiltration
- **PHSE1.0**: excessive SE can create a hydrophilic channel

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- **Tafel curves:** PHSE coatings increased passivity, and SE inhibited corrosion ➜ less dramatic ICORR increase
- **SEM**: Morphological changes after corrosion test
- **Cyclic Corrosion Test:** Slower corrosion progress than PH

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- **Increasing adhesion** with a slight decrease in hardness
- **Finite Element Analysis**: mechanical behavior
- **Composite Zone Model**: More SE resulted in higher interfacial toughness ➜ requires more force for peeling.

Conclusions

Key takeaways from the research work

Protection

Enough SE content to provide strong adhesion

Avoids SE-saturation that yields water pathway - PHSE0.5 to be the optimized loading

Characterization

Investigation of the samples before and after immersion

Characterizing using EIS, PD curves, FTIR, MALDI MS, SEM-EDX, TGA, WCA, SFE, and XPS

Mechanical

Experimental + numerical assessment of durability

Determine the mechanical behavior of the additive and adhesive + hardness quality

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