

Broad bean stalk extract as a novel green inhibitor on cold rolled steel corrosion in HCl solution

Ran Lei, Shuduan Deng, Feifei Chen, Xianghong Li*

College of Materials and Chemical Engineering, Southwest Forestry University,
Kunming 650224, P.R. China

e-mail address: xianghong-li@163.com

Abstract: Agricultural waste of broad bean (*Vicia faba*) stalks extract (VFSE) was prepared in this work. The corrosion inhibition properties of VFSE on cold rolled steel (CRS) in 1.0 M HCl solution were investigated. The result showed that the corrosion inhibition effect of VFSE was significant, and the maximum inhibition efficiency was 90.3% with 100 mg L⁻¹ of VFSE. VFSE adsorption on the CRS surface conformed to the Langmuir adsorption isotherm, and increasing VFSE concentration resulted in higher impedance values. In addition, the surface micromorphology test indicated that VFSE formed an adsorption film on CRS surface, which effectively retarded HCl corrosion of CRS. TOF-SIMS, XPS and other test results further confirmed the binding of corrosion inhibitor molecules to CRS. The main components of VFSE were determined by LC-MS analysis. Through theoretical calculations, it was found that the active sites of these main components adsorb vigorously to CRS substrates, theoretically confirming the corrosion inhibition effect of VFSE.

Keywords: Corrosion inhibitor, Steel, *Vicia faba* stalk extract, Adsorption, Molecular simulations

Reference

- [1] A. S. Sowmyashree, A. Somya, S. Rao, C.B. Pradeep Kumar, A. N. Al-Romaizan, M. A. Hussein, A. Khan, H. M. Marwani, A. M. Asiri, Potential sustainable electrochemical corrosion inhibition study of Citrus limetta on mild steel surface in aggressive acidic media, J. Mater. Res. Technol. 24 (2023) 984-994.
- [2] Q. Zhang, B. Hou, Y. Li, G. Zhu, Y. Lei, X. Wang, H. Liu, G. Zhang, Dextran derivatives as highly efficient green corrosion inhibitors for carbon steel in CO₂-saturated oilfield produced water: experimental and theoretical approaches, Chem. Eng. J. 424 (2021) 130519.

[3] L Qiu, X Li, D Xu, D. Shao, G. Du, S. Deng, Comparison of the corrosion inhibition property on cold rolled steel in sulfuric acid media between reflux and ultrasound extracts from rapeseed meal, *Ind. Crops Prod.* 216 (2024) 118809.

[4] P. Du, S. Deng, G Du, D. Shao, D. Xu, X. Li, Synergistic inhibition effect of *Mikania micrantha* extract with potassium iodide on the corrosion of cold rolled steel in methanesulfonic acid solution, *Corros. Sci.* 220 (2023) 111296.

[5] A. Chaouiki, H. Lgaz, R. Salghi, M. Chafiq, H. Oudda, Shubhalaxmi, K. S. Bhat, I. Cretescu, I. H. Ali, R. Marzouki, I. M. Chung, Assessing the impact of electron-donating-substituted chalcones on inhibition of mild steel corrosion in HCl solution: experimental results and molecular-level insights, *Colloids Surf., A* 588 (2020) 124366.

Acknowledgements

Funding support from National Natural Science Foundation of China (52161016), Joint Key Project of Agricultural Fundamental Research in Yunnan Province (202101BD070001-017) are acknowledged, Open Fund Project of State Forestry and Grassland Administration Key Laboratory of Southwest Forestry Biomass Resources Efficient Utilization in Southwest Region, Southwest Forestry University (2022-KF08), and Yunnan University Student Innovation and Entrepreneurship Training Program (s202310677073).