Visual Guide to Major Pitfalls in Voltammetry: Recognition, Interpretation, and Practical Solutions

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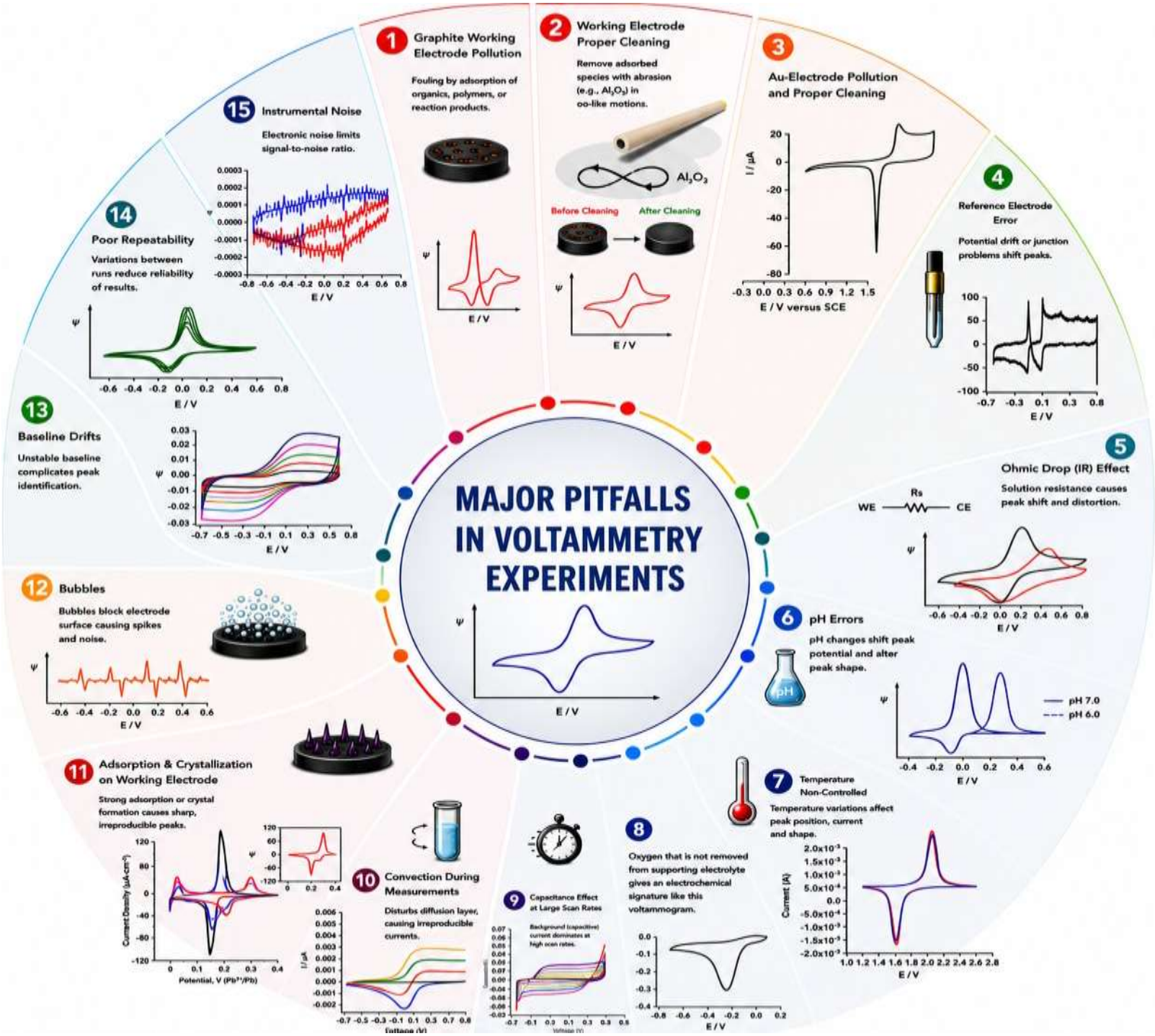
Abstract

Voltammetry is among the most versatile electroanalytical techniques owing to its simplicity, relatively low instrumental cost, rapid data acquisition, and exceptional capability to provide qualitative and quantitative information on electrochemical systems. During the past 50 years, it has become an indispensable tool in biochemistry, pharmaceutical analysis, environmental chemistry, corrosion science, battery research, nanotechnology, enzymatic electrochemistry, biosensor development, green energy conversion, and biomedical materials research. Beyond analytical applications, voltammetry provides valuable mechanistic insight into electron-transfer processes, reaction kinetics, thermodynamic properties, adsorption phenomena, catalytic activity, molecular stability, chemical reactivity, and coupled homogeneous reactions. Despite its apparent experimental simplicity, reliable interpretation of voltammetric responses requires both a sound understanding of electrochemical theory and careful control of numerous experimental variables. Many common experimental artifacts produce voltammetric signatures that closely resemble genuine electrochemical phenomena and may therefore lead to incorrect mechanistic or analytical conclusions. This educational review presents a comprehensive visual overview of the major pitfalls encountered in voltammetric experiments, including working and reference electrode problems, electrode memory effects, ohmic drop, insufficient supporting electrolyte, dissolved oxygen interference, convection, adsorption, crystallization, temperature and pH effects, capacitive currents, instrumental noise, baseline drifts, peak overlap, bubble formation, and poor repeatability. For each phenomenon, characteristic voltammetric signatures, underlying physicochemical origins, methods of recognition are presented. The visual guide provided here is intended to facilitate more reliable experimental practice and

improve the interpretation, reproducibility, and overall quality of voltammetric investigations for students, researchers, and practicing electrochemists.



REFERENCES

1. R. Gulaboski, Journal of Solid State Electrochemistry 24 (2020) 2081-2081

2. R. Gulaboski, E. S. Ferreira, C. M. Pereira, M. N. D. S. Cordeiro, A. Garau, V. Lippolis, A. F. Silva, Journal of Physical Chemistry C 112 (2008) 153-161

3. V. Mirceski, M. Lovric, R. Gulaboski, Journal of Electroanalytical Chemistry 515 (2001) 91-100.

4. R Gulaboski, V Mirceski, Macedonian Journal of Chemistry and Chemical Engineering 39 (2020) 153-166

5. V. Mirceski, R. Gulaboski, Macedonian Journal of Chemistry and Chemical Engineering 33 (2014), 1-12

6. V. Mirceski, R. Gulaboski, Journal of Solid State Electrochemistry 7 (2003) 157-165

7. M. Janeva, P. Kokoskarova, V. Maksimova, R. Gulaboski, Electroanalysis 31 (2019) 2488-2506

8. R. Gulaboski, V. Mirceski, S. Komorsky-Lovric, M. Lovric, Electroanalysis 16 (2004) 832-842

9. R. Gulaboski, C.M. Pereira, M.N.D.S Cordeiro, I. Bogeski, F. Silva, Journal of Solid State Electrochemistry 9 (2005) 469-474

10. B. Sefer, R. Gulaboski, V. Mirceski, Journal of Solid State Electrochemistry 16 (2012) 2373-2381.

11. P. Kokoskarova, Rubin Gulaboski, Electroanalysis 32 (2020) 333-344.

https://doi.org/10.1002/elan.201900491

12. R. Gulaboski, C. M. Pereira, Electroanalytical Techniques and Instrumentation in Food Analysis; in Handbook of Food Analysis Instruments (2008) 379-402.

13. M. Jorge, R. Gulaboski, C. M. Pereira, M. N. D. S. Cordeiro, Journal of Physical Chemistry B 110 (2006) 12530-12538.

14. V. Mirceski, D. Guziejewski, L. Stojanov, R. Gulaboski, Analytical Chemistry 91 (2019) 14904-14910.

15. V. Mirceski, R. Gulaboski, F. Scholz, Journal of Electroanalytical Chemistry 566 (2004) 351-360.

16. R. Gulaboski, M. Chirea, C. M. Pereira, M. N. D. S. Cordeiro, R. B. Costa, A. F. Silva, J. Phys. Chem. C 112 (2008) 2428-2435

17. R. Gulaboski, V. Mirceski, S. Komorsky-Lovric, M. Lovric, Electroanalysis 16 (2004) 832-842

18. R. Gulaboski, C. M. Pereira, M. N. D. S. Cordeiro, A. F. Silva, M. Hoth, I. Bogeski, Cell Calcium 43 (2008) 615-621

19. R. Gulaboski, V. Mirceski, F. Scholz, Amino Acids 24 (2003) 149-154

20. V. Mirceski, R. Gulaboski, Croatica Chemica Acta 76 (2003) 37-48.

21. F. Scholz, R. Gulaboski, Faraday Discussions 129 (2005) 169-177.

22. R. Gulaboski, K. Caban. Z. Stojek, F. Scholz, Electrochemistry Communications 6 (2004) 215-218.

23. V. Mirceski, R. Gulaboski, Journal of Physical Chemistry B, 110 (2006) 2812-2820.

24. V. Mirceski, R. Gulaboski, B. Jordanoski, S. Komorsky-Lovric, Journal of Electroanalytical Chemistry, 490 (2000) 37-47.

25. R. Gulaboski, Macedonian Journal of Chemistry and Chemical Engineering 41 (2022) 151-162

26. R. Gulaboski, P. Kokoskarova, S. Petkovska, Analytical&Bioanalytical Electrochemistry, 12 (2020) 345-364.

27. V. Mirčeski, R. Gulaboski, F. Scholz, Electrochemistry Communications 4 (2002) 814-819

28. M. Jorge, R. Gulaboski, C. M. Pereira, M. N. D. S Cordeiro, Molecular Physics 104 (2006) 3627-3634.

29. R. Gulaboski, V. Mirceski, M. Lovric, Macedonian Journal of Chemistry and Chemical Engineering 40 (2021) 1-9.

30. R. Gulaboski, P. Kokoskarova, S. Risafova, J. Electroanal. Chem. 868 (2020) 114189.

31. R. Gulaboski, V. Mirceski, Journal of Solid State Electrochemistry 28 (2024) 1121-1130.

32. V. Mirceski, B. Mitrova, V. Ivanovski, N. Mitreska, A. Aleksovska, R. Gulaboski, Journal of Solid State Electrochemistry 19 (2015) 2331-2342.

33. I. Spirevska, L. Soptrajanova, R. Gulaboski, Analytical Letters 33 (2000) 919-928.

34. R. Gulaboski, B. Jordanoski, Bulletin of Chemists and Technologist of Macedonia 19 (2000) 177-181

35. R. Gulaboski, M. Lovrić, V. Mirčeski, I. Bogeski, M. Hoth, Biophysical Chemistry 137 (2008) 49-55.

36. R. Gulaboski, V. Mirčeski, S. Mitrev, Food Chemistry, 138 (2013) 116-121.

37. R. Gulaboski, V. Mirčeski, M. Lovrić, Journal of Solid State Electrochemistry 23 (2019) 2493-2506

38. V. Mirceski, R. Gulaboski, F. Scholz, Electrochemistry Communications 4 (2019) 814-819.

39. R. Gulaboski, V. Mirceski, Journal of Solid State Electrochemistry 28 (2024) 1121-1130.

40. R. Gulaboski, F Borges, C.M. Pereira, M. Cordeiro, J. Garrido, A.F. Silva, Combinatorial chemistry & high throughput screening 10 (2007), 514-526

41. Gulaboski, R.; Bogeski, I.; Kokoskarova, P.; Haeri, H. H.; Mitrev, S.; Stefova, M.; Stanoeva, J. P.; Markovski, V.; Mirčeski, V.; Hoth, M.; Kappl, R. New Insights into the Chemistry of Coenzyme Q-0: A Voltammetric and Spectroscopic Study. *Bioelectrochemistry* **2016**, *111*, 100– 108.

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