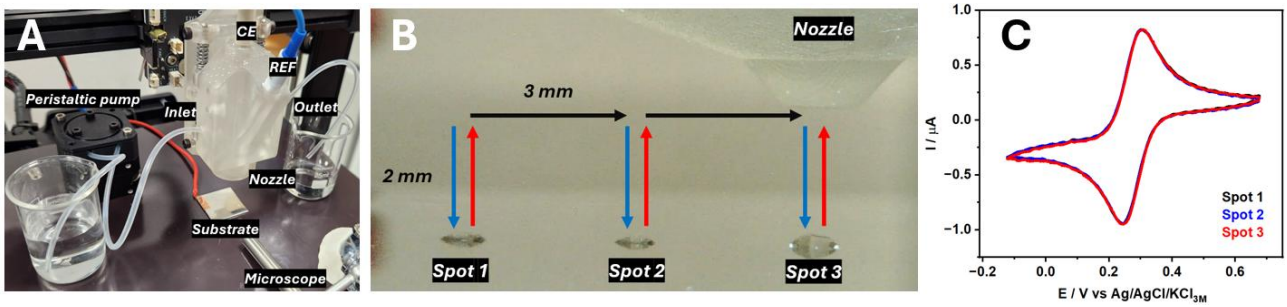
Customizable Scanning Droplet Cell Platform Based on Commercial 3D-Printer for Spatially Resolved Electrochemistry

Rafael Silva Santos[1*], Gabriel N. Meloni[1]
[1] Instituto de Química - Universidade de São Paulo, São Paulo, Brazil
e-mail: rafael.ss@usp.br

Scanning droplet cell (SDC) is a technique that enables localized electrochemical measurements by confining an electrolyte droplet at a nozzle in contact with a conductive surface, forming a small confined electrochemical cell [1]. SDC allows spatially resolved electrochemistry in the micrometer range, being attractive for electrocatalysis, battery research, and corrosion studies, where mapping local reactivity and heterogenity is essential [1-3]. However, most existing SDC implementations rely on costly commercial equipment that provide limited customization and flexibility, limiting integration with other analyses techniques . Here, we present a low-cost, customizable SDC platform based on the hardware and positioning system of a commercial 3D printer (Fig. 1A). The system is fully controlled via Python integrating X, Y and Z movement, control of a 3D printed peristaltic pump and a commercial potentiostat (PalmSens4), enabling automated scanning procedures (Fig. 1B). Custom nozzles and SDC scanning heads 3D printed with photopolymer resin allow for droplet confinement with spatial resolution defined by the nozzle inner diameter, which can be printed as small as ~250 µm (Fig. 1C). System performance was accessed by cyclic voltammetry on a platinum substrate using ferricyanide, showing reproducible electrochemical cell area (Fig. 1C) and suitability for spatially resolved electrochemical measurements. The easy customization enables the integration of additional techniques, such as Raman spectroscopy, by simply changing the head configuration and software procedure to produce a multimodal analyses platform.



(A) Developed SDC platform using 3D-printer hardware and photopolymer resin. (B) Microscope image of the SDC nozzle performing the scanning procedure at 3 different spots and the electrolyte residue left at the surface. (C) Cyclic voltammograms recorded in multiple spots on the Pt substrate showing consistent voltammetric profiles.

Acknowledgments:

FAPESP processes: 2024/14586-1 and 2021/00800-3

References:

[1] M. M. Lohrengel et al, Fresenius J Anal Chem, 367, 334–339 (2000) [2] David Muñoz-Torrero et al, RSC Adv.,13, 15521-15530 (2023) [3] B. DeCost et al, JOM, 74, 2941–2950, (2022)