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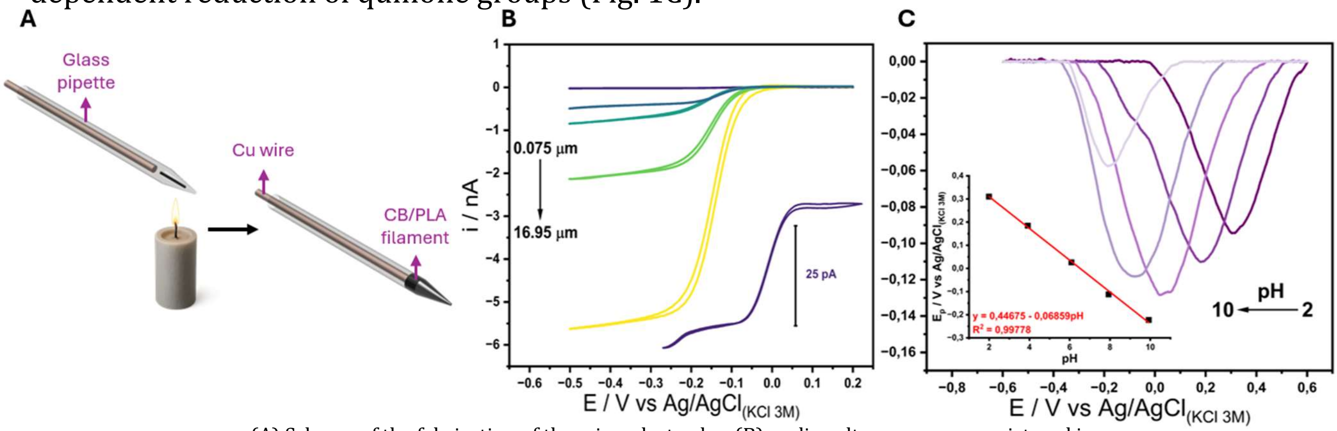
Simple fabrication method of needle-type carbon-disk nano and microelectrodes using conductive thermoplastics

Luiz F. Z. Felipe[1*], Gabriel N. Meloni[1]

[1] Instituto de Química - Universidade de São Paulo, São Paulo, Brazil

**e-mail: luizf21@usp.br*

Carbon fiber and pyrolyzed carbon nano and microelectrodes are widely used in electrochemistry and analytical electrochemistry, from sensing to space-resolved electrochemical methods. In sensing, it is often used for detecting neurotransmitters, such as dopamine, due to their biocompatibility, small size, and surface oxides that enhance dopamine adsorption. However, most fabrication methods are either time-consuming and yield low reproducibility or require complex instrumentation [1]. 3D-printing is an emerging fabrication technique for electrodes utilizing conductive thermoplastics, like carbon black/polylactic acid (CB/PLA), but due to spatial resolution limitations, can only fabricate electrodes with radii larger than 35 µm [2]. Here we present a simple and quick approach, leveraging on the low melting point of CB/PLA thermoplastics used in 3D printing to fill micro and nano quartz pipettes with conductive carbon (Fig. 1A) and fabricate needle-type disk microelectrodes with radii smaller than 35 µm and down to a few 100 nm (Fig. 1B). We leverage on the very small radius of glass around the electrodes (RG) [3] for space resolved electrochemical methods and on the carbon surface chemistry to fabricate micrometer sized pH sensors based on the pH-dependent reduction of quinone groups (Fig. 1C).



(A) Scheme of the fabrication of the microelectrodes, (B) cyclic voltammograms registered in $[Ru(NH_3)_6]^{3-}$ 1 mM with microelectrodes of different diameters (scan rate: 50 mV/s) and (C) baseline corrected square wave voltammograms registered in BR buffer of different pHs and the plot of the reduction potential peak in function of the pH.

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References:

[1] McCreery, R. L., Chem. Rev. 2008, 108, 2646-2687. [2] Xue, Z. et al., Anal. Chem. 2024, 96, 12701-12709. [3] Zoski, C. G.; Mirkin, M. V., Anal. Chem. 2002, 74, 1986-1992.