PÔSTER - RESUMO - INOVAÇÃO

IMPEDANCE ANALYSIS AS AN ENABLING FRAMEWORK FOR ACCESSIBLE BIOSENSING AND PHYSIOLOGICAL ASSESSMENT TECHNOLOGIES

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Portable and accessible instrumentation remains a cornerstone for translating electronic and biosensing material breakthroughs into real-world tools. During my MSc [1] at Bernhard Gross Polymers Group (IFSC/USP), we developed a low-cost portable impedance analyzer (SIMPLE-Z) to bridge the accessibility gap left by expensive bench-top spectrometers. Built around the integrated circuit AD5933, the system features custom peripheral circuitry and firmware that allow for adjustable excitation (10mV to 1V), an expanded frequency range (1Hz to 100kHz), and automated calibration. With a production cost near USD 100 (roughly ten times cheaper than commercial alternatives) the device was validated against a Solartron 1260A using tissue-equivalent circuits, maintaining magnitude errors under 1% and phase errors below 1.5°. This platform proved effective for characterizing biofunctionalized interfaces and thin films, such as Langmuir-Blodgett and layer-by-layer assemblies. Specifically, a DNA-based genosensor for SARS-CoV-2 reached attomolar sensitivity, showing that portable spectroscopy is viable for point-of-care diagnostics. This work led to a Brazilian patent [2] and provided the necessary infrastructure to link materials science with applied sensing. The technology was later licensed to the startup I created, Blatron, where SIMPLE-Z was refined for the market, resulting in over ten units deployed across research and educational labs. Continued support from a FAPESP PIPE Phase 2 program focused on enhancing robustness, speed, and usability, highlighting the hurdles of moving academic hardware toward scalable production. Building on this foundation, my PhD research introduces Bioimpedance Spectro-Tomography (BIST). This project integrates spectroscopy with electrical impedance tomography via multiplexed tetrapolar acquisition, modular electrode arrays, and physics-informed machine learning. The goal is to achieve spatially resolved physiological mapping by solving the ill-posed inverse problem through spectroscopic-constrained regularization. Initial validation involves controlled physical phantoms to ensure methodological reliability before moving to biological tests. By treating impedance analysis as a bridge for sensing research, this work establishes a clear line from hardware development to technology transfer and next-generation diagnostic systems.

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References:

[1] L. A. Buscaglia, “Development of a Portable Impedance Spectrometer,” Mestrado em Física Aplicada, Universidade de São Paulo, São Carlos, 2022\. doi: 10.11606/D.76.2022.tde-19072022-120227.

[2] L. A. Buscaglia, J. P. Carmo, and O. N. Oliveira Jr., “Sistema e dispositivo de medição de espectro de impedância elétrica portáteis,” BR 10 2021 020940 2

Palavras-chave: impedance; spectroscopy; tomography; spectro-tomography; biosensing;.