Modification of inkjet printed graphene electrode surface by intense pulsed light for improved voltammetric sensing and biosensing

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Inkjet printing offers a green and cost-effective route for fabricating miniaturized, disposable electrochemical sensors. It uses less conducting material, yet it remains underdeveloped compared to screen printing. Inkjet-printed ion-selective electrodes are easily realized [1], since the bulk of the electrode resistance comes from the polymeric ion-selective membrane. However, due to the reduced amount of the printed conducting material, voltammetric sensing with inkjet printed electrodes is more challenging.

In this talk, flexible low-cost inkjet printed graphene electrodes on polyimide sheets will be presented (Figure 1). After printing, the electrodes are processed by intense pulsed light (IPL) – a photonic processing technology that delivers high intensity white light in short time intervals or bursts. The IPL treatment lasts only 3 ms, yet these electrodes outperform thermally treated inkjet printed electrodes and commercial screen-printed carbon electrodes in terms of electrochemical and electroanalytical performance. IPL processing causes the formation of craters on the electrode surface, thus increasing the electroactive surface area and facilitating electron transfer (demonstrated with a hexacyanoferrate (II/III) redox probe). Consequently, voltammetric determination of the antibiotic azithromycin showed improved sensitivity in both batch and flow analysis [2].

The versatility of IPL-processed electrodes was further demonstrated for biosensing: the electrodes were modified by inkjet printing of a Prussian Blue nanoparticle suspension. This enabled sensitive amperometric determination of hydrogen peroxide at low potentials. In the last step, lactate oxidase was immobilized, and lactate determined (via determination of the enzymatically produced hydrogen peroxide) in a broad linear range covering sweat lactate concentrations [3]. Systems like this should enable the development of a variety of low-cost flexible miniature sensors and biosensors, particularly attractive for distributed and wearable sensing.

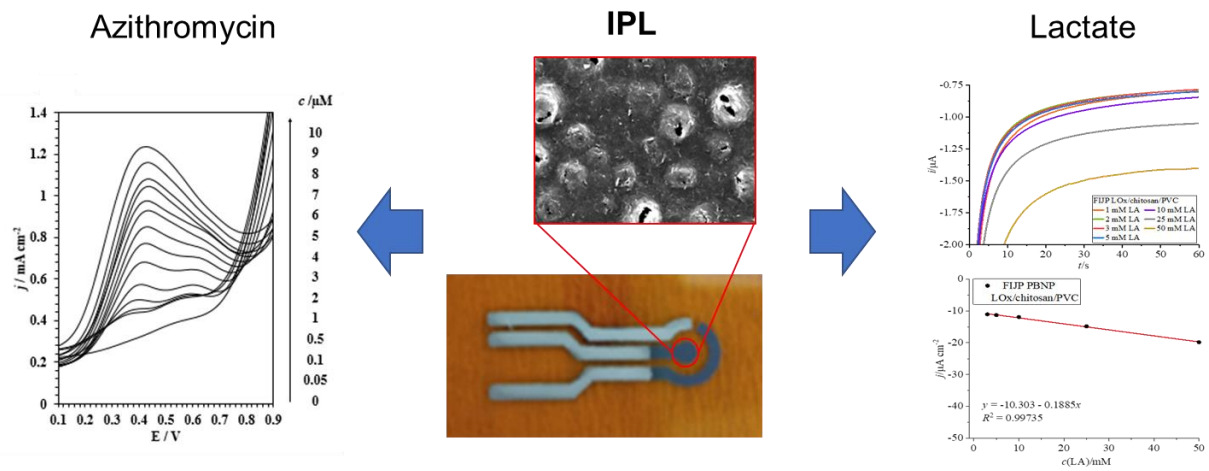

Figure 1: IPL processing improves determination of azithromycin and lactate.

Acknowledgments

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References

[1] 1. S. Krivačić, Ž. Boček, M. Zubak, V. Kojić, P. Kassal, *Talanta* **279** (2024) 126614.
[2] 2. M. Zubak, P. Kassal, *Electrochim. Acta* **513** (2025) 145561.
[3] 3. Ž. Boček, M. Zubak, P. Kassal, *Biosensors* **15** (2025) 28.