Área: ELE

Exploring the impact of laser scan gap on the electrochemical response of electrodes manufactured by laser-induced carbon pyrolysis.

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Highlights

The impact of different CO_2 laser scan gaps on the electrochemical performance of resulting electrodes is investigated. Changing the scan gap impacts the analytical response of electroanalytical methods.

Resumo/Abstract

Laser-induced pyrolysis to fabricate electrochemical devices from carbon-based polymers is very attractive. It involves a single fabrication step and can be used on several inexpensive substrates, including flexible ones. The electrode geometry is formed by selective pyrolyzing substrate regions using a CO_2 laser, moving in a raster pattern. The impact of fabrication parameters, besides laser power, on the electrochemical response of these electrodes has yet to be investigated in depth. We investigate the impact of the scan gap (the separation between each line in the raster pattern - Fig.1A) on the electrochemical response of electrodes using the outer-sphere redox probe $[Ru(NH)_6]^{3+}$. Scan gap values between 0.1 and 0.025 mm were investigated, and the cathodic and anodic peak potential difference (ΔE_p – Fig. 1B gray) and current ratios (I_{pA}/I_{pc} - Fig. 1B red) of voltammograms recorded with $[Ru(NH)_6]^{3+}$were used to quantify the electrochemical response. A trend of decreased I_{pA}/I_{pc} with decreased scan gap is seen, while ΔE_p decreased to a certain point, followed by a decrease, pointing to an optimal gap value.

Similarly, the absolute value of the cathodic and anodic currents approaches the expected value for the electrode geometric area and then decreases. These analyses suggest that at large scan gaps, only a partial area of the electrode surface is electroactive, whit these parts interconnected and separated by non-pyrolyzed phenolic islands. Most of the surface is pyrolyzed at the optimal scan gap, and the separation between the electroactive areas allows for diffusional overlap. At the smaller scan gap, the electrode surface might be degraded by the continuous laser incidence. Electrodes fabricated with the optimal scan gap (smaller ΔE_p and closer to unit I_{pA}/I_{pc}) were used, as a proof of concept, to detect fluoroquinolones (Levofloxacin) and then compared with GCE electrodes at the same conditions. When the obtained result is contrasted with what is obtained for the largest gap electrode, it is clear that optimizing the fabrication parameters can have a huge impact on the development of electrochemical sensors.

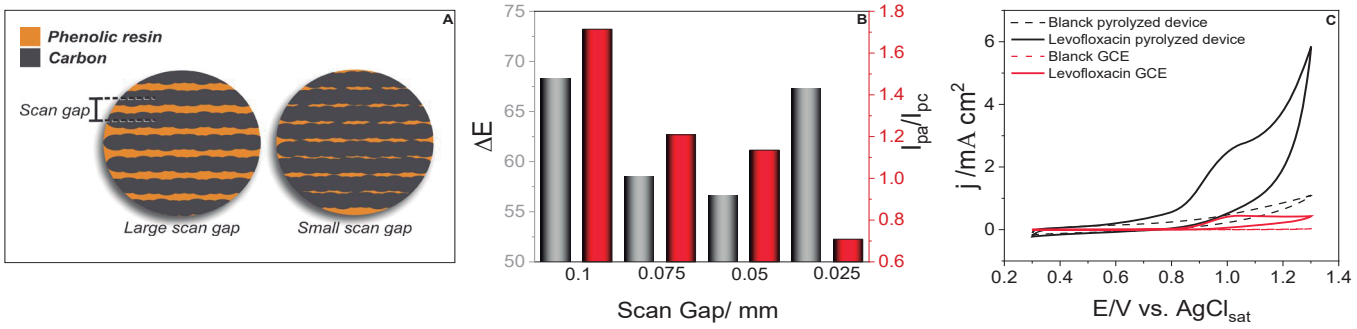

Figure 1 – A) Schematic representation of substrate pyrolysis varying scan gaps distance B) Effect of the scan gaps distance on ΔE (gray bars) and I_{pA}/I_{pc} (red bars). C) CVs recorded in the absence (dashed lines) and presence (solid lines) of 1.0 mmol L^{-1} Levofloxacin using GCE electrodes (red lines) and pyrolyzed electrodes (black lines). Supporting electrolyte PBS buffer pH 7 and scan rate 50 mv s^{-1}.

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