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LIG-Gold electrodeposition V.1

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Protocol status: In development
We are still developing and optimizing this protocol

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Abstract

This protocol describes a reproducible method to fabricate gold-nanoparticle-decorated laser-induced graphene (LIG) electrodes via electrochemical deposition.

Overview

1 This protocol describes the process of gold electrodeposition on laser-induced graphene (LIG) electrodes by the chronoamperometry technique using a MultiPalmSens4. Figure 1 depicts the process. The time must be changed according to the number of samples you have. The resulting LIG/Au electrode is suitable for biosensing applications, including pathogen detection, enzymatic sensing, and aptamer-based assays.

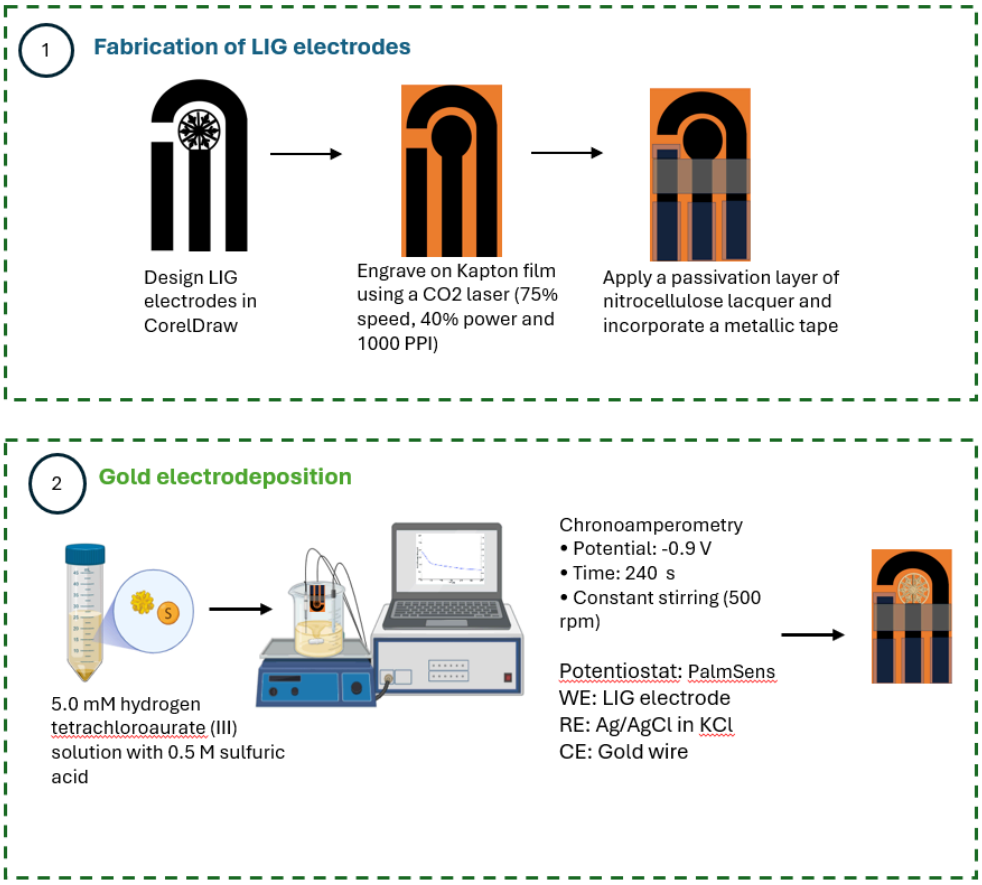

Figure 1. Electrodeposition of Laser Induce Graphene Electrodes

Materials and reagents

2
- Kapton film (electrical grade polyimide film, 0.0050″ thick)
- Chemical-resistant polyvinyl chloride (PVC) sheets (1/16″ thick)
- Metal alloy tape

- Lacquer (passivation coating)
- Deionized water (DI)
- Isopropyl alcohol (IPA)
- Gold(III) chloride trihydrate ($HAuCl_4 \cdot 3H_2O$)
- Sulfuric acid (H_2SO_4), 1 N *(Note: 1 N H_2SO_4 corresponds to 0.5 M H_2SO_4 because H_2SO_4 is diprotic; see preparation notes below.)*
- Silver/silver chloride (Ag/AgCl) reference electrode
- Gold-wire counter electrode
- Female USB 2.0 (Type A) connectors

Equipment and software

3
- Universal Laser System (VLS3.60) and CorelDRAW (Corel Corporation)
- Potentiostat: Multi PalmSens4 (PalmSens BV, Houten, The Netherlands) with MultiTrace software.
- Magnetic stirrer (capable of 500 rpm) and standard three-electrode cell stand.
- Standard laboratory glassware, pipettors, and safety equipment.

Platform fabrication (LIG)

4
- Design a three-electrode layout (working, reference, counter) in CorelDRAW
- Laser inscription settings: distance from lens to sample surface = **5.0 cm**; **one scan**; burn-in power pulse = **40 ms**; **75% pulses per inch**; burn-in speed = **1000**. (Adjust as needed for your laser model.)
- Apply metal tape at the electrode pads to serve as robust bonding pads and to protect LIG during electrical connections.
- Apply a thin layer of lacquer as passivation over the electrode shafts, leaving the active working area exposed.
- Rinse electrodes briefly with DI water, allow to dry, and store in a dust-free container until use.

Gold Electroplating Solution Preparation

5 **5.0 mM $HAuCl_4$** prepared in **0.5 M H_2SO_4**.
*Note: if using **1 N H_2SO_4** stock (≈0.5 M), the 1 N solution can be used directly as the supporting electrolyte and diluted accordingly when preparing the final plating solution*

Equipment Setup

6
- Assemble a three-electrode cell: LIG working electrode (immersed working area exposed to solution), **Ag/AgCl (3 M KCl)** reference electrode, and a **Pt-wire** counter electrode (or a gold wire if preferred for charge balance — ensure consistent method across experiments). Connect to the Multi PalmSens4 potentiostat.

- Place the cell on a magnetic stirrer and set stirring to **500 rpm** (continuous stirring during deposition).

Gold electrodeposition

7
- Using the chronoamperometry technique, set a **constant potential of −0.90 V** (vs Ag/AgCl) for **240 s** (4 minutes).
- Ensure the working area is fully and reproducibly immersed in the plating solution.
- After deposition, immediately remove the electrode and rinse thoroughly with DI water.
- Optionally, perform additional characterization (SEM, EDX, or electrochemical impedance spectroscopy) if instrumentation is available

💡 Tips

8 **Safety (acid handling):** When preparing or diluting sulfuric acid, always add acid to water (never water to acid). Use appropriate PPE: acid-resistant gloves, lab coat, eye protection, and work in a fume hood when handling concentrated acids.

Protocol references

Tang, Y., Casso Hartmann, L., Bahamon Pinzon, D., Am Moreira, G., Vanegas, D., & S McLamore, E. (2022). *Electrochemical analysis of laser-inscribed graphene electrodes using cyclic voltammetry (ferri/ferrocyanide redox couple) v2*. Springer Science and Business Media LLC. https://doi.org/10.17504/protocols.io.4r3l27q7jg1y/v2

Rauf, S., Lahcen, A. A., Aljedaibi, A., Beduk, T., Ilton de Oliveira Filho, J., & Salama, K. N. (2021). Gold nanostructured laser-scribed graphene: A new electrochemical biosensing platform for potential point-of-care testing of disease biomarkers. *Biosensors and Bioelectronics*, *180*, 113116. https://doi.org/10.1016/j.bios.2021.113116