DEVELOPMENT OF AN ADVANCED SURFACE ENGINEERED PLATINUM-BASED ELECTROCHEMICAL SYSTEM FOR ULTRA-SENSITIVE DETECTION OF MELOXICAM UTILIZING CHITOSAN TO SUPPRESS OXYGEN

Hassan Kouchakzadeh[1], Šarūnas Žukauskas[1]

[1]Department of Nanotechnology, State Research Institute Center for Physical Sciences and Technology, Sauletekio av. 3, Vilnius, LT-10257, Lithuania
hassan.kouchakzadeh@ftmc.lt

Rheumatoid Arthritis (RA) requires long-term management with Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) like Meloxicam (MLX). It is a widely used NSAIDs and developing an electrochemical sensor for its sensitive detection is a strategic move to address the limitations of traditional pharmaceutical and clinical analysis [1-2]. While standard methods like High-Performance Liquid Chromatography (HPLC) are accurate, they are often time-consuming, expensive, and require sophisticated laboratory infrastructure [3]. In this work, an rGO/AuNPs electrochemical sensor for MLX is developed by the drug's intrinsic redox activity and the clinical need for rapid, cost-effective monitoring in arthritic patients as a theragnostic microneedle system (Figure 1). By replacing traditional, labor-intensive chromatographic methods with a portable electrochemical platform, real-time dosing adjustments can be made, enhancing therapeutic efficacy while minimizing systemic side effects. In this regard, for the designing and optimum fabrication of a high-performance nanocomposite transducer layer on a Platinum (Pt) electrode surface for MLX detection, graphene oxide (GO) concentration (0.5-1.5 mg/mL), HAuCl4 concentration (0.5-2.5 mM) and deposition time (100-500 second) considered as the independent variables considering the limit of detection (LOD) for MLX as the main response. Central Composite Design (CCD), which is more powerful than a Box-Behnken Design (BBD), is selected for design experiments [4]. For 3-factor optimization, a CCD designed 20 runs, 8 Factorial Points, 6 Axial (Star) Points, and 6 Center Points. A one-step potentiostatic co-reduction method [5] employs to achieve a high-performance rGO/AuNPs interface on a Platinum (Pt) electrode. The findings and optimum procedure ensure that the GO and Gold ions (Au3+) are reduced simultaneously, creating a cohesive, 3-dimensional conductive network suitable for highly sensitive MLX detection.

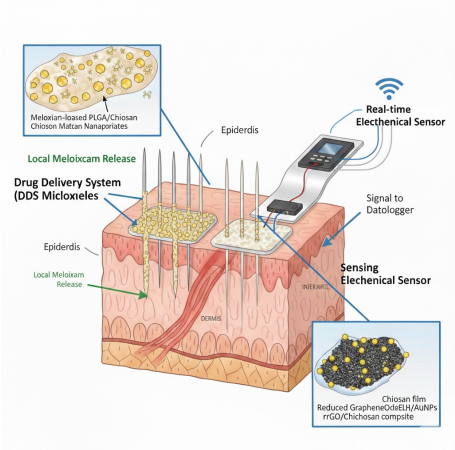

Fig. 1. schematic representation of theragnostic microneedle system

[1] J. S. Smolen, D. Aletaha, and I. B. McInnes, "Rheumatoid arthritis," The Lancet, vol. 388, no. 10055, pp. 2023–2038, May 2016, doi: 10.1016/s0140-6736(16)30173-8.
[2] Brune and P. Patrignani, "New insights into the use of currently available non-steroidal anti-inflammatory drugs," Journal of Pain Research, vol. 8, p. 105, Feb. 2015, doi: 10.2147/jpr.s75160.
[3] T. Lupoi, Y. R. Leroux, B. Feier, C. Cristea, and F. Geneste, "Electrochemical and photoelectrochemical aptasensors for the detection of environmental pharmaceutical pollutants," Electrochimica Acta, vol. 530, p. 146396, May 2025, doi: 10.1016/j.electacta.2025.146396.
[4] D. C. Montgomery, Design and analysis of experiments. John Wiley & Sons, 2017.
[5] C.-S. Lee, S. Yu, and T. Kim, "One-Step electrochemical fabrication of Reduced Graphene Oxide/Gold nanoparticles Nanocomposite-Modified electrode for simultaneous detection of dopamine, ascorbic acid, and uric acid," Nanomaterials, vol. 8, no. 1, p. 17, Dec. 2017, doi: 10.3390/nano8010017.