Diamond and Ti_3C_2 optical transparent electrodes for optoelectrochemical measurements

M. Sobaszek[1], M. Strąkowski[1], I. Kaczmarzyk[1], R. Vitter[2] and M. Szczerska[1]
[1] *Gdańsk University of Technology, Faculty of Electronics, Telecommunications and Informatics, Department of Metrology and Optoelectronics, 11/12 Narutowicza Str., 80-233, Poland*
[2]*Institute of Atomic Physics and Spectroscopy, University of Latvia, 19 Raina Blvd., LV-1586 Riga, Latvia*
micsobas@pg.edu.pl

1. Introduction

Due to their excellent electrochemical properties, boron-doped diamond (BDD) electrodes have a wide working-potential window, low background current, and inherent biocompatibility. However, to optimize their performance, surface modification is necessary. BDD electrodes are transparent within the visible range (300-900 nm) and far-IR, and their optical properties can be tailored by adjusting the deposition conditions.[1–4] Compared to indium-doped tin oxide (ITO) electrodes on quartz, diamond optically transparent electrodes (OTE) offer superior reproducibility, responsiveness, and stability in harsh chemical environments.

Ti_3C_2 MXene is a material with unique optical properties, particularly in its absorption of visible and ultraviolet light.[5] Its large absorption coefficient in the visible region makes it a promising material for photovoltaic and photocatalytic applications, while its tunable bandgap energy enables applications in photonics and optical sensing. Additionally, Ti_3C_2 MXene exhibits strong fluorescence emission, which makes it a potential candidate for bioimaging and sensing applications. However, further research is necessary to fully understand and exploit its optical properties.

Spectroelectrochemistry is a powerful tool used for electrochemical measurements, employing absorption spectroscopy in various regions of the electromagnetic spectrum.[6] However, high concentrations are required for some spectroelectrochemical measurements due to insufficient band intensity, which poses a challenge for data correlation. To address this issue, we propose a novel approach to spectroelectrochemistry based on interferometric measurements of refractive index changes. Using a Mach-Zehnder interferometer (MZI), we can achieve precise measurements of refractive index with a sensitivity of up to 1.8×10^{-6} refractive index units (RIU).[7]

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