# Graphene transparent electrodes for POCT devices based on ECL immunoassay

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Our group aims to fabricate CVD graphene-based devices such as transparent antennas [1] and biosensors for point-of-care (POC) testing [2].

POC devices that allow rapid diagnosis and early treatments are in great demand for monitoring infectious diseases. While the outbreak of COVID-19 led to the widespread use of rapid test kits using lateral flow immunoassay (LFIA) for visual detection, there was a growing demand for rapid test kits with higher sensitivity and quantitative measurement. Electrochemiluminescence (ECL)-based immunoassays are recognized as more reliable analytical methods, although they are very rarely used in rapid test kits. CVD-grown graphene films are suitable materials for ECL-based analytical platforms for POCT because they can be used as disposable transparent electrodes. The use of transparent electrodes allows the photodetector to be placed directly below the electrode, which increases the light collection angle and facilitates the placement of other electrodes.

So far we have demonstrated that CVD-grown graphene films transferred onto quartz glass by the PMMA method exhibit better ECL performance than glassy carbon and ITO electrodes and enable ECL-based immunoassays for a tumor marker, carcinoembryonic antigen (CEA) [2].

In this study, porous nitrocellulose/graphene stacked films were fabricated as a platform for biochips for ECL analysis for POCT. Porous nitrocellulose is used as a support material for biomolecules such as antibodies, including membranes for LFIA. When fabricating CVD graphene transparent electrodes, a transfer process from the catalyst metal (Cu) to the transparent substrate is essential, and PMMA is commonly used as a transfer support material. We performed graphene transfer using a porous nitrocellulose membrane as an alternative to PMMA. By optimizing the preparation conditions of cellulose membranes, a porous membrane with sufficient electrolytic solution permeability and strength to be used as a transfer supporting material was successfully fabricated (Fig. 1). Furthermore, ECL-based immunoassay was successfully demonstrated using the cellulose/graphene stacked films loaded with anti-CEA antibody (Fig. 2).

## References

[1] Shinji Koh, Shohei Kosuga et al., Carbon Reports, 2 (2023) 23-30.
[2] Takeshi Watanabe, Ryohei Ishikawa et al., Electrochemistry Communications, 138 (2022) 107290.

## Figures

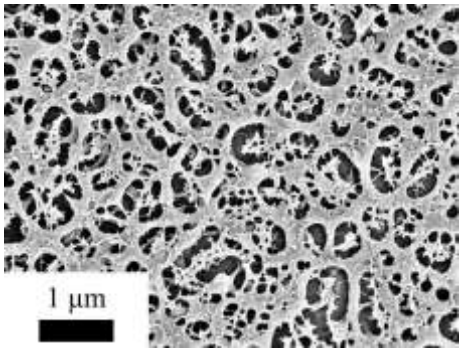


**Figure 1**: SEM image of porous cellulose.

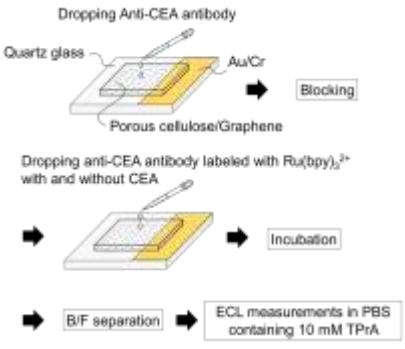


**Figure 2**: ECL-based immunoassay using cellulose/graphene films.