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We present a sensitive and low-cost immunoassay, based on a customized open-source quartz crystal microbalance coupled with graphene bio-interface sensors (G-QCM), to quantify antibodies in undiluted patient serum. We demonstrate its efficacy for a specific antibody against the phospholipase A2 receptor (anti-PLA2R), which is a biomarker in idiopathic membranous nephropathy, a progressive kidney disease. A novel graphene-protein bio-interface was constructed by adsorbing a low concentration of denatured bovine serum albumin (dBSA) on the reduced graphene oxide (rGO) sensor surface. The dBSA film prevents the denaturation of the protein receptor on the rGO surface and serves as the cross-linker for immobilization of the receptor for anti-PLA2R antibodies on surface. The detection limit and selectivity of this G-QCM biosensor was compared with a commercial QCM system. The G-QCM immunoassay exhibited good specificity and high sensitivity toward the target, with an order of magnitude better detection limit (of 100 ng/ml) compared to the commercial system, at a fraction of the cost and with considerable time saving. The results obtained from patient sera compared favourably with those from enzyme-linked immunosorbent assay (ELISA), validating the feasibility of use in clinical applications. The multifunctional dBSA-rGO platform provides a promising bio-functionalization method for universal immunoassay and biosensors. With the advantages of inexpensive, rapid and sensitive detection, the G-QCM sensor and instrument form an effective autoimmune disease screening tool.

References

[1] Hampitak, P.; et al; Carbon, 2020, 165, 317-327.
[2] Hampitak, P.; et al; ACS Sensors, 2020, In Press.
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Figures

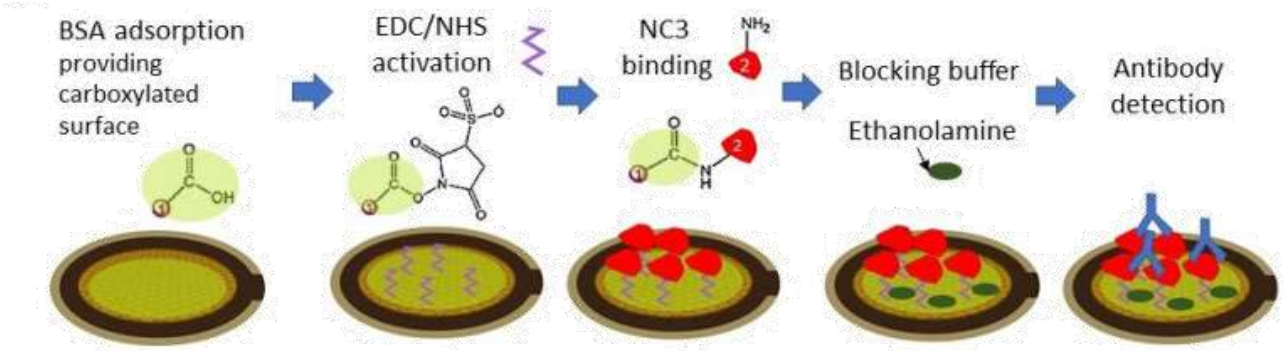

Figure 1: Schematic for functionalization of rGO surface to detect the antibodies starting with BSA adsorption, amine activation with EDC/NHS, immobilization of the receptor NC3 (in red) via amine covalent cross-link and blocking with ethanolamine.