Development of electrochemical biosensors using functionalized boron doped diamond as a point-of-care label-free detector for SARS-COV-2

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Abstract:
The conductive boron doped diamond (BDD) electrode has emerged as excellent material for electroanalytical studies. When doped with boron, the diamond becomes a semiconductor, that is both chemically inert, and maintains a wide aqueous electrochemical potential window. While, diamond is chemically inert, the surface can be modified to maintain a variety of functional group handles. Such modifications include, hydrogen or oxygen termination, and more advanced methods include salinization and electrografting. Here, we report on our efforts to modify the BDD surface through grafting a diazonium salt, which forms a stable interface handle due to the formation of covalent bonds. Using this intermediate, we are having linked transducer surface and bio-recognizing elements to use for electrochemical measurements. In the present study, the hydrogen terminated BDD electrodes surface was grafted with 4-carboxybenzene diazonium tetrafluoroborate using cyclic voltammetry, in which 4-aminobenzoic acid was used as source of diazonium salt. The X-ray photoelectron spectroscopy (XPS), contact angle, and electrochemical analysis confirms the existence of diazonium salt over the BDD surface. The adequately available carboxylic groups associated with diazonium salt over BDD electrode surface provide a microenvironment to covalently attach monoclonal antibody specific to SARS-CoV-2 via 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide and N-hydroxysuccinimide chemistry. The bioelectrode was then treated with blocking buffer to mask the unspecific sites on the electrode surface before being used to quantify a range of SARS-CoV-2 concentrations. The proposed electrografted BDD-based electrochemical biosensing platform demonstrated high sensitivity and selectivity in SARS-CoV-2 detection.

Keywords: Electrochemistry, Biosensor, Functionalization, Point-of-care device

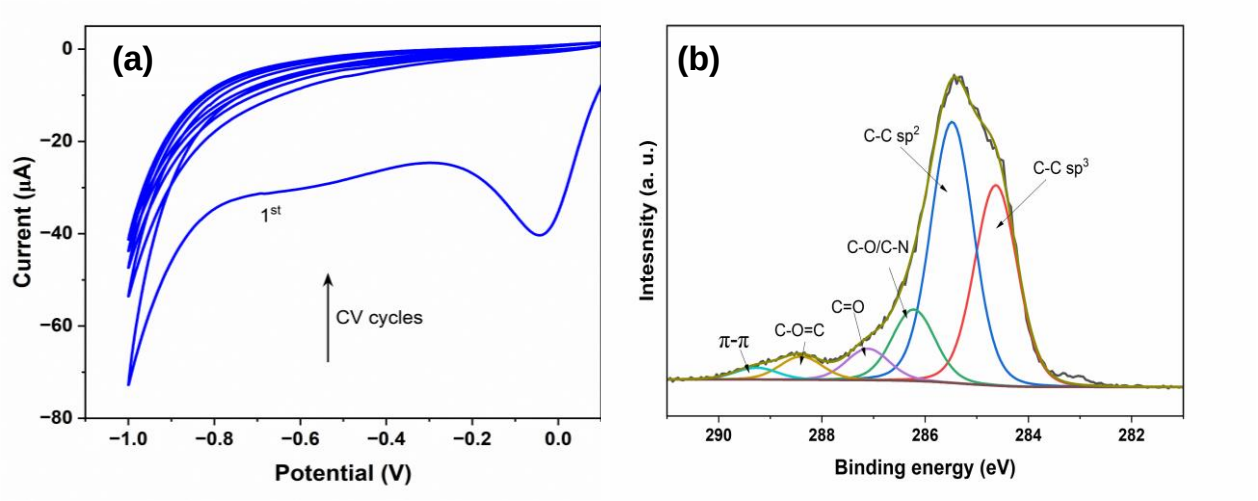

Figure. (a) Cyclic voltammetry scans (1-5) of a BDD electrode in 1M HCl containing 2 mM 4-aminobenzoic acid and 2.2 mM $NaNO_2$ as it is being electrografted. **(b)** Representative high resolution XPS spectra of the C1s of a 4-carboxybenzene diazonium tetrafluoroborate grafted BDD electrode.