Data collected during the execution of an NWO-XS grant "Innovative single-step approach to printable and flexible diamond sensors"

Authors: S. van Leeuwen, S. Baluchova

Department of Precision and Microsystems Engineering (PME), Faculty of Mechanical Engineering (ME), Delft University of Technology

Corresponding author: S. Baluchova

Contact information: s.baluchova@tudelft.nl (simona.baluchova@natur.cuni.cz)

This dataset includes:

1. Raman spectroscopy

- Raman spectra of boron-doped diamond (BDD) powders (commercially obtained from Boromond and Ultrahard China) were collected at room temperature using a Horiba LabRAM HR spectrometer equipped with an x, y, z moving stage.
- Excitation source: a Cobolt fandango 50 argon-ion laser operating at 514 nm wavelength and 50 mW.
- Range: from 200 to 1800 cm^{-1}.

2. Scanning electron microscopy (SEM)

- JEOL scanning electron microscope (JEOL-JSM6010LA) operating at an acceleration voltage of 5 and 20 kV.
- Prior to measurements, samples (filaments, 3D-printed electrodes) were coated with a thin layer of gold using a JEOL JFC-1300 auto fine coater to enhance the conductivity during the measurement.
- SEM also used to investigate both BDD powders (particle size and shape).

3. Digital microscopy

- Optical images were taken with a Keyence Digital Microscope VHX-6000.
- The filament cross-section images - *x30 objective lens* and the images of the electrode surfaces - *x50 and x100 objective lens*.

4. Particle size distribution

- The particle-size distribution of both BDD powders was measured by laser light scattering using a Malvern Mastersizer 3000 instrument with a Hydro SM wet sample dispersion unit.
- BDD powder was dispersed in deionized water and added to the wet dispersion unit.

5. Mechanical measurements

- Uniaxial tensile tests performed using a Zwick & Roell tensile testing machine with a constant pulling rate of 20 mm/min.
- Yield and stiffness properties were evaluated from three specimens.
- Printed composite samples were dumbell-shaped with dimensions according to the ASTM D-638 (type V).

6. Electrical measurements

- The electrical properties investigated using a digital multimeter (Voltcraft CV820-1) equipped with two probes.
- The probes were manually positioned at fixed distances on the composite filaments and samples, and the obtained resistances were converted to volume resistivity.

7. Electrochemical measurements

- All performed using an Autolab PGSTAT 128N controlled by Nova 2.1 software under laboratory conditions (23 °C).
- Conventional 3-electrode setup: working electrode (WE) – a 3D-printed composite electrode, reference electrode – a silver-silver chloride electrode, counter electrode – a platinum wire.
- WE placed in a 25 mm x 25 mm sample holder with a 1 cm^2 aperture.
- Cyclic voltammetry (CV) conducted in the solutions of 0.5 M KNO_3 (to estimate double-layer capacitance), 1mM $[Ru(NH_3)_6]^{3+/2+}$ and 1mM $[Fe(CN)_6]^{3-/4-}$, both in 0.5 M KNO_3 (to assess electro transfer rate kinetics), using various scan rates.
- For the detection of dopamine (1 mM, in 10 mM phosphate buffered saline of pH 7.4), differential pulse voltammetry (DPV) was used. Scans were recorded using a pulse amplitude of +25 mV, pulse width of 50 ms, potential step of 2.5 mV and a scan rate of 5 mV/s.