Graphene derivative-based ink advances inkjet printing technology for fabrication of electrochemical sensors and biosensors

Martin-Alex Nalepa
David Panáček, Ivan Dědek, Petr Jakubec, Vojtěch Kupka, Vítězslav Hrubý, Michal Otyepka
Regional Centre of Advanced Technologies and Materials – Czech Advanced Technology and Research Institute (CATRIN), Palacký University Olomouc, Křížkovského 511/8, 779 00 Olomouc, Czech Republic
martinalex.nalepa@upol.cz

The development of biosensors could greatly benefit from a new method for producing electrodes via inkjet printing technology, which offers a precise and reproducible manufacturing process. In this regard, we introduce a nitrogen-doped carboxylated graphene ink (NGA-ink), specifically formulated to be compatible with existing inkjet printing systems. This water-based, additive-free ink enables the fabrication of fully inkjet-printed electrodes (IPEs) capable of electrochemical detection of dopamine, an essential neurotransmitter. The cost-effectiveness of NGA-ink, with a total cost per electrode of just $0.10, makes it a compelling option for on-demand customized electrode production. Additionally, the high carboxyl group concentration (13 wt%) in NGA-ink improves its potential for biomolecule immobilization, thus facilitating the development of advanced biosensors. IPEs made from this ink were fully functional and demonstrated promising electrochemical activity and stability. In summary, the introduction of NGA-ink marks a significant advancement in sensor technology, providing a scalable, cost-efficient, and environmentally friendly solution with improved performance capabilities for advanced biosensing applications. The ability of this ink to enable covalent attachment of biomolecules, such as antibodies or aptamers, opens new possibilities for advanced sensor development and the creation of fully inkjet-printed biosensors.

References

[1] Nalepa M.-A. et al. Biosensors and Bioelectronics, 256 (2024): 116277.

Figures

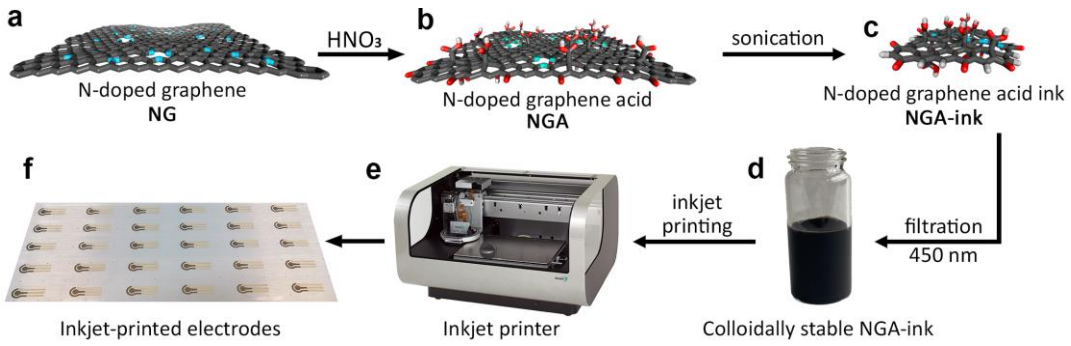

Figure 1: Synthesis of the NGA-ink. Nitrogen-doped graphene (a) is treated with nitric acid, forming carboxyl functionalities. Resulting material, nitrogen-doped graphene acid (b) is filtered and sonicated. Obtained NGA-ink dispersion (c) is filtered through a 450 nm filter to form colloidally stable NGA-ink (d). This ink is then used in printing process utilizing inkjet printer (e). In this way, fully inkjet-printed electrodes (f) can be produced. [1]