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Paper published in an international journal of exceptional value (M21a): Real-time detection of ochratoxin A in wine through insight of aptamer conformation in conjunction with graphene field-effect transistor

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Mycotoxins comprise a frequent type of toxins present in food and feed. The problem of mycotoxin contamination has been recently aggravated due to the increased complexity of the farm-to-fork chains, resulting in negative effects on human and animal health and, consequently, economics. The easy-to-use, on-site, on-demand, and rapid monitoring of mycotoxins in food/feed is highly desired.

In this work, we report on an advanced mycotoxin biosensor based on an array of graphene field-effect transistors integrated on a single silicon chip. A specifically designed aptamer against ochratoxin A (OTA) was used as a recognition element, where it was covalently attached to graphene surface via pyrenebutanoic acid, succinimidyl ester (PBASE) chemistry. Namely, an electric field stimulation was used to promote more efficient π-π stacking of PBASE to graphene. The specific G-rich aptamer strand suggest its π-π stacking on graphene in free-standing regime and reconfiguration in G-quadruplex during binding an OTA molecule. This realistic behavior of the aptamer is sensitive to the ionic strength of the analyte solution, demonstrating a 10-fold increase in sensitivity at low ionic strengths. The graphene-aptamer sensors reported here demonstrate fast assay with the lowest detection limit of 1.4 pM for OTA within a response time as low as 10 s, which is more than 30 times faster compared to any other reported aptamer-based methods for mycotoxin detection. The sensors hold comparable performance when operated in real-time within a complex matrix of wine without additional time-consuming pre-treatment.