Electrochemical detection of multiple RNA targets using MXene/duplex-specific nuclease: A path towards simultaneous detection of SARS-CoV-2 and H1N1 influenza virus

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Rapid and sensitive detection of SARS-CoV-2 in an affordable fashion is vital for the early diagnostics of the COVID-19. Moreover, with the inevitable emergence of the upcoming seasonal influenza (flu), it is highly important to differentiate influenza virus from SARS-CoV-2 in order for the healthcare professionals to prescribe the most appropriate medications. We have developed a novel biosensor for the concurrent detection of two short RNA strands (microRNA-21 and microRNA-141) that is being upgraded for the SARS-CoV-2 and H1N1 influenza virus. A MXene-$Ti_3C_2T_x$ is synthesized and modified with 5 nm gold nanoparticles (AuNP@MXene) and drop-casted on a home-made dual screen printed gold electrode (SPGE). Two DNA probes ($Base^{21}$ and $Base^{141}$) are identically immobilized on each working electrodes to form $Base^{21}$/AuNP@MXene/SPGE and $Base^{141}$/AuNP@MXene/SPGE). Two magnetic particles (MPs) are conjugated with two different ssDNAs labelled with ferrocene (Fc) and methylene blue (MB), which are partly complementary to the target RNAs. After target binding and the DNA:RNA heteroduplex formation, the DNA is cleaved by duplex-specific nuclease (DSN) leaving the target RNA intact for further reactions. The cleavage, releases the over-hanged labelled ssDNAs to be hybridized with their corresponding $Base^{21}$/AuNP@MXene/SPGE and $Base^{141}$/AuNP@MXene/SPGE following by two discrete electrochemical signals arising from MB and Fc. AuNP@MXene provided spacious accordion-like host for immobilization of vast numbers of DNAs and represented a great charge mobility by offering 4 times higher electrochemical signal than that of the AuNPs alone. The proposed biosensor could detect both target RNAs in 80 min with the detection limits of 204 aM and 138 aM and a wide linear range from 500 aM to 50 nM demonstrating promising features for the fabrication of practical devices.

REFERENCES

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FIGURES

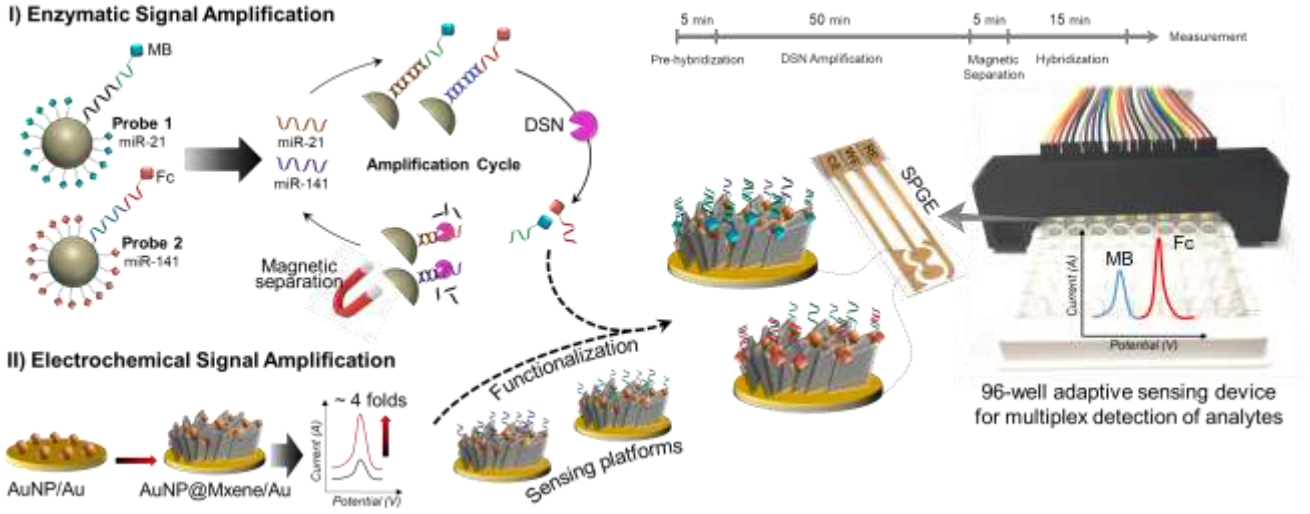

Figure 1: Schematic diagram of the multiple detection of target RNAs.