Researchers develop novel DNA biosensor for early diagnosis of cervical cancer

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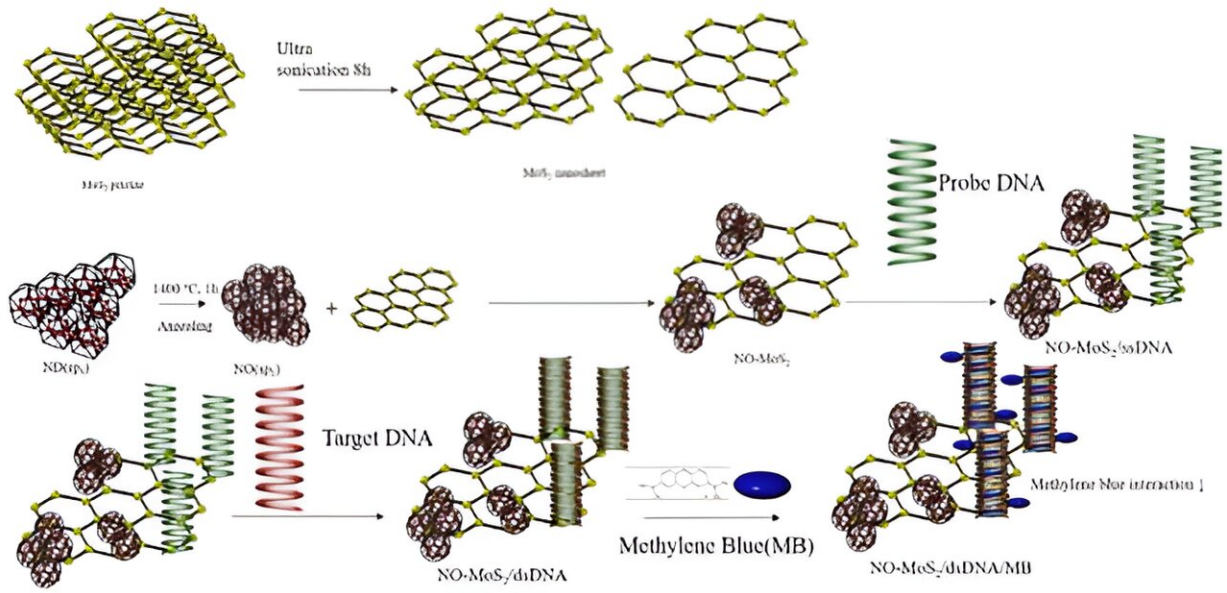

Chung-Ang University researchers have developed a novel electrochemical nano-onion/molybdenum disulfide nanosheet composite-based DNA biosensor that efficiently and specifically detects human papillomavirus (HPV)-16 and HPV-18, enabling early diagnosis of cervical cancer. Credit: *Journal of Nanobiotechnology*

Molybdenum disulfide (MoS_2) has recently garnered attention among materials science researchers owing to its ability to form two-dimensional nanosheets like graphene. The nanosheets are created by the stacking of S–Mo–S layers interacting via Van der Waals interactions.

Additionally, the unique structural, optical, thermal, and electrochemical properties of MoS_2 have opened up multiple research avenues across several fields, including the development of biomolecule sensing and chemical detection platforms, optoelectronics, supercapacitors, and batteries.

Traditionally, carbon nanostructures have been employed as an immobilization platform for DNA. In order to substitute carbon with MoS_2 as an effective electrochemical DNA sensor, the electrical conductivity of MoS_2 needs to be improved considerably.

Against this backdrop, Associate Professor Eunah Kang and Mr. Youngjun Kim from the School of Chemical Engineering and Material Science at Chung-Ang University, Korea have recently come up with an elegant solution. The duo has developed an electrochemical DNA biosensor using a graphitic nano-onion/molybdenum disulfide (MoS_2) nanosheet composite, which effectively detects human papillomavirus (HPV)-16 and HPV-18, and can serve as an early diagnosis of cervical cancer.

"Nano-onions possess graphitic sp_2 structures and are derived from crystalline sp_3nanodiamonds via thermal annealing or laser irradiation," explains Dr. Kang. Their breakthrough was published in the *Journal of Nanobiotechnology*.

The researcher duo prepared the novel electrode surface for probing DNA chemisorption by enabling chemical conjugation between two functional groups: acyl bonds on the surfaces of functionalized nano-onions and amine groups present on the modified MoS_2 nanosheets.

Cyclic voltammetry experiments revealed that a 1:1 composite electrode had an improved rectangular shape compared to that of an MoS_2 nanosheet electrode. "This indicated the amorphous nature of the nano-

onions with curved carbon layers that facilitated an enhancement in electronic conductivity compared to MoS_2 nanosheet alone," highlights Dr. Kang.

Additionally, the duo measured the sensitivity of their novel electrochemical DNA biosensor device towards HPV-16 and HPV-18 by employing differential pulse voltammetry (DPV) technique in the presence of methylene blue (MB) as a redox indicator. Dr. Kang says, "The DPV current peak was lowered after probe DNA chemisorption and target DNA hybridization. Since the hybridized DNA was double-stranded, it induced less effective MB electrostatic intercalation, resulting in a lower oxidation peak."

The duo found that, compared to the MoS_2 nanosheet electrode, the nano-onion/MoS_2 nanosheet composite electrode attained higher current peaks, indicating a greater change in the differential peak. This was attributed to an enhanced conductive electron transfer owing to the nano-onion.

Notably, the target DNAs produced from HPV-16 and HPV-18 Siha and Hela cancer cell lines were detected by the proposed sensor effectively and with high specificity. Consequently, MoS_2 nanosheets with improved electrical conductivity facilitated by complexation with nano-onions provides a suitable platform for developing effective and efficient electrochemical biosensors for the early diagnosis of a wide variety of ailments, including cervical cancer.

Furthermore, combining nano-onions or nanodiamonds with different organic biomaterials can facilitate chemical functionality, electron transfer conductivity, light absorption, and more. These, in turn, can lead to innovative disease sensing, targeted drug delivery systems, and biomedical imaging and diagnostics.

More information: Youngjun Kim et al, A graphitic nano-onion/molybdenum disulfide nanosheet composite as a platform for HPV-associated cancer-detecting DNA biosensors, *Journal of Nanobiotechnology* (2023). DOI: 10.1186/s12951-023-01948-6

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