DOI 10.5162/IMCS2018/P1BS.2

# Electrochemical Paper-based DNA Sensor for Human Papillomavirus Detection

*Prinjaporn Teengam*[1], *Weena Siangproh*[2], *Adisorn Tuantranont*[3], *Charles S. Henry*[4], *Tirayut Vilaivan*[5], *Orawon Chailapakul*[6,7,*]

[1]*Program in Petrochemistry, Chulalongkorn University, Pathumwan, Bangkok, 10330, Thailand*
[2]*Department of Chemistry, Faculty of Science, Srinakharinwirot University, Bangkok, 10110, Thailand*
[3]*Nanoelectronics and MEMS Laboratory, National Electronics and Computer Technology, Pathumthani, 12120, Thailand*
[4]*Department of Chemistry, Colorado State University, Fort Collins, Colorado 80523, United State*
[5]*Organic Synthesis Research Unit, Department of Chemistry, Faculty of Science, Chulalongkorn University, Pathumwan, Bangkok, 10330, Thailand*
[6]*Electrochemistry and Optical Spectroscopy Center of Excellence, Department of Chemistry, Chulalongkorn University, Pathumwan, Bangkok, 10330, Thailand*
[7]*National Center of Excellence for Petroleum, Petrochemicals, and Advanced Materials, Chulalongkorn University, Pathumwan, Bangkok, 10330, Thailand*

**Abstract**

A novel paper-based electrochemical biosensor using an anthraquinone-labeled pyrrolidinyl peptide nucleic acid (acpcPNA) probe (AQ-PNA) and graphene-polyaniline (G-PANI) modified electrode was developed for human papillomavirus (HPV) detection. An inkjet printing technique was employed to prepare the paper-based G-PANI-modified working electrode. The AQ-PNA probe baring a negatively charged amino acid at the N-terminus was immobilized onto the electrode surface through electrostatic attraction. Electrochemical impedance spectroscopy (EIS) was used to verify the AQ-PNA immobilization. The paper-based electrochemical DNA biosensor was used to detect an oligonucleotide target with a sequence corresponding to HPV type 16 by measuring the electrochemical signal response of the AQ label using square-wave voltammetry before and after hybridization. After the addition of target DNA, the current signal significantly decreased. This phenomenon is explained by the rigidity of PNA-DNA duplexes, which obstructs the accessibility of electron transfer from the AQ label to the electrode surface. Under optimal conditions, the linearity in the range of 10-200 nM with the detection limit of 2.3 nM was obtained. The performance of this biosensor on real DNA samples was tested with the detection of PCR-amplified DNA samples from the SiHa cell line. The proposed method employs an inexpensive and disposable device and is promising for the screening and monitoring of the amount of HPV-DNA type 16 to identify the primary stages of cervical cancer.

**Key words:** Paper-based DNA sensor, Human Papillomavirus, Graphene, Polyaniline, acpcPNA