**Novel biomarker assays based on photothermal effects and nanophotonics**

by

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ABSTRACT

 The early diagnosis of terminal diseases such as cancers has been a long-sought goal of the medicine community. To achieve this goal, many diagnostic tools have been developed, including various types of X-ray examination, mammography, sigmoidoscopy, colonoscopy, pap tests and fecal occult blood tests, etc. These techniques can only discover the disease after the tumor has grown to an appreciable size or there has already been a significant amount of anomalous cells circulating in the blood, which in some cases cannot be considered early enough for a diagnosis. To detect and diagnose even earlier, immunoassays have been developed to detect the biomarkers related to certain physical conditions. Among the various types of immunoassays, enzyme-linked immunosorbent assay and lateral flow assay are two representative formats, the former being a wet-lab precision assay and the latter a rapid home-use qualitative test. They have been widely used for medical and research purposes but they have drawbacks such as costly instruments and lack of sensitivity. To improve their performance, we have developed photoacoustic-based detection schemes that can be easily integrated with currently existing immunoassay formats and can increase the sensitivity and accuracy as well as lower the costs. Limit of detection has been lowered by two orders of magnitude for both assays with low-cost and portable instruments. As a follow up of the photoacoustic detection schemes, a technique based on photothermal lens is also investigated. We have also utilized one-dimensional photonic crystal substrates to enhance the photoacoustic and photothermal signals. Due to the guided-mode resonance of the photonic crystal substrate, the signals can be enhanced by 10 to 40 times.