Rapid Electrochemical Detection of Cancer Biomarkers on disposable inkjet-printed Au-Immunoarrays

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Conventional immunoassays often take many hours to complete, but more rapid, are needed for point-of-care (POC) and surgical applications in cancer diagnostics. This paper describes a low-cost ink-jet printed sensor chip integrated into a simple microfluidic immunoarray for low sample volume detection of two cancer biomarker proteins each within 8 mins. The 8-electrode array chips are fabricated by ink-jet printing of 4 nm alkylthiol gold nanoparticles onto plastic. The gold arrays are printed on heat treatable Kapton polymer sheets and insulated by over-printing with a Kapton precursor layer, then annealed. The resulting gold sensor elements are coated with self-assembled monolayers providing functionality to attach capture antibodies to their surfaces. Magnetic beads of 1 μm diam. derivatized with ~300,000 horseradish peroxidase labels and thousands of antibodies capture the biomarker proteins from samples off-line to provide high sensitivity and ultralow detection limits (DL). These particles are captured by antibodies on the sensor surface, and activated and measured by injection of hydrogen peroxide and hydroquinone mediator into the device. For an assay time of 45mins, detection limits for interleukin (IL)-6 and IL-8 approach 20 fg mL^{-1}. We decreased the assay time by sacrificing the high sensitivity, and obtained a clinically relevant DL of 5 pg mL^{-1} with dynamic range of 5 to 200pg mL^{-1} in 8 min. assays. Accuracy was demonstrated by determining IL-6 and IL-8 in conditioned growth media from head and neck squamous cell carcinoma (HNSCC) cells and demonstrated good correlation to those obtained by standard single-protein ELISAs. Results indicate that this fast immunoarray protocol could be employed for rapid detection of a wide range of proteins. For example, such an approach could be adapted to detect biomarker proteins in surgical samples or to detect inflammation during cancer therapy.