ORIENTED TAILORING OF PLASTIC ANTIBODIES FOR PROSTATE SPECIFIC ANTIGEN AND APPLICATION OF THE IMPRINTED MATERIAL AS IONOPHORE IN POTENTIOMETRIC DETECTION*

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Prostate Specific Antigen (PSA) is the biomarker of choice for screening prostate cancer throughout the population, with PSA values above 10 ng/mL pointing out a high probability of associated cancer[1].
According to the most recent World Health Organization (WHO) data, prostate cancer is the commonest form of cancer in men in Europe[2]. Early detection of prostate cancer is thus very important and is currently made by screening PSA in men over 45 years old, combined with other alterations in serum and urine parameters. PSA is a glycoprotein with a molecular mass of approximately 32 kDa consisting of one polypeptide chain, which is produced by the secretory epithelium of human prostate.
Currently, the standard methods available for PSA screening are immunoassays like Enzyme-Linked Immunoabsorbent Assay (ELISA). These methods are highly sensitive and specific for the detection of PSA, but they require expensive laboratory facilities and high qualify personal resources. Other highly sensitive and specific methods for the detection of PSA have also become available and are in its majority immunobiosensors[1,3-5], relying on antibodies. Less expensive methods producing quicker responses are thus needed, which may be achieved by synthesizing artificial antibodies by means of molecular imprinting techniques. These should also be coupled to simple and low cost devices, such as those of the potentiometric kind, one approach that has been proven successful[6]. Potentiometric sensors offer the advantage of selectivity and portability for use in point-of-care and have been widely recognized as potential analytical tools in this field. The inherent method is simple, precise, accurate and inexpensive regarding reagent consumption and equipment involved.
Thus, this work proposes a new plastic antibody for PSA, designed over the surface of graphene layers extracted from graphite. Charged monomers were used to enable an oriented tailoring of the PSA rebinding sites. Uncharged monomers were used as control. These materials were used as ionophores in conventional solid-contact graphite electrodes. The obtained results showed that the imprinted materials displayed a selective response to PSA. The electrodes with charged monomers showed a more stable and sensitive response, with an average slope of -44.2 mV/decade and a detection limit of $5.8X10^{-11}$ mol/L (2 ng/mL). The corresponding non-imprinted sensors showed smaller sensitivity, with average slopes of -24.8 mV/decade. The best sensors were successfully applied to the analysis of serum samples, with percentage recoveries of 106.5% and relatives errors of 6.5%.

1. Y. Liu, “Electrochemical detection of prostate-specific antigen based on gold colloids/alumina derived sol-gel film”, Thin Solid Films, 516, 2008, pp. 1803-1808.
2. W. H. O. (WHO), http://www.who.int/mediacentre/factsheets/fs297/en/index.html,2008.
3. H. Jans, K. Jans, P.-J. Demeyer, K. Knez, T. Stakenborg, G. Maes, and L. Lagae, “A simple double-bead sandwich assay for protein detection in serum using UV-vis spectroscopy”, Talanta, 83, 2011, pp. 1580.
4. K. W. Wee, G. Y. Kang, J. Park, J. Y. Kang, D. S. Yoon, J. H. Park, and T. S. Kim, “Novel electrical detection of label-free disease marker proteins using piezoresistive self-sensing micro-cantilevers”, Biosensors & Bioelectronics, 20, 2005, pp. 1932.
5. Y. Uludag and I. E. Tothill, “Development of a sensitive detection method of cancer biomarkers in human serum (75%) using a quartz crystal microbalance sensor and nanoparticles amplification system”, Talanta, 82, 2010, pp. 277.
6. T. Rebelo, S. Almeida and M. Sales, “Trimethoprim-selective electrodes with molecularly imprinted polymers acting as ionophores and potentiometric transduction on graphite solid-contact”, Microchemical Journal, 98, 2011, pp. 21–28.

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