

# Detection of Alzheimer's Disease Biomarkers and Mycotoxins using Spectroscopic Ellipsometry

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# Abstract

Neurological diseases such as Alzheimer's, Parkinson's, MS, which are common around the world and particularly in developed countries with high proportion of elderly, stimulate the development of bio-sensors for early diagnostics of such diseases. For instance the treatment of Alzheimer's patients constitutes a substantial proportion of NHS budget nowadays. Therefore, the development of highly sensitive optical devices for early diagnoses of Alzheimer's disease (AD) will be beneficial to society. This PhD is mainly dedicated to the application of the method of Spectroscopic Ellipsometry for AD diagnostics. Total Internal Reflection Ellipsometry (TIRE) was utilized in this work as an immunosensor for detection of Amyloid Precursor Protein 770 (APP<sub>770</sub>) and beta amyloid peptide (A $\beta$ <sub>1-16</sub>). The detection of low concentrations of APP<sub>770</sub> in a complex medium containing other proteins, salts, and amino acids was achieved using the method of TIRE in direct immuno assay with monoclonal DE2 antibodies. The calibration of TIRE with a complementary QCM measurements in air allowed the evaluation of (originally unknown) concentration of APP<sub>770</sub> as 121 pmol/l. The immune reaction between APP<sub>770</sub> and DE2 antibodies was also tested using QCM technique operating in liquid. The application of TIRE was extended to the detection of much smaller peptide A $\beta$ <sub>1-16</sub> which bind to the same DE2 antibody. The results were very encouraging since low concentrations (0.05 ng/ml) of A $\beta$ <sub>1-16</sub> were detected; this showed good prospects for detection of A $\beta$ <sub>40-42</sub>, an actual marker of AD.

The second part of this work was dedicated to detection of mycotoxins, a hazardous contaminant in agriculture products (grains) and associated food and feed. Two mycotoxins, namely Aflatoxins B1 and Zearalenone, were detected in TIRE direct immunoassay. Zearalenone was also detected using TIRE competitive assay. The obtained limits of detection of 0.04 ng/ml for Aflatoxin and 0.1 ng/ml for Zearalenone are well below the legislation limit. Such remarkable results are due to a combination of high sensitivity of TIRE method and the aggregation of hydrophobic molecules of mycotoxins in aqueous solutions. A new method of purification of substances contaminated with mycotoxins based on the use of polyelectrolyte microcapsules functionalized with specific antibodies was successfully tested in this work.

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