MAGNESIUM SENSING BASED ON DIELECTROPHORETICALLY TRAPPED CARBON NANOTUBES

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Magnesium is an intracellular cation, acts as a co-factor in more than 300 enzymatic reactions in human body and in addition to many other significant roles Mg^{2+} ensures proper nerve and muscle functions. Recently it has been founded that there is a relationship between serum Mg^{2+} levels and the severity of Alzheimer's disease; therefore, the determination of Mg^{2+} level at various stages of the disease is recommended in order to understand the progression and treatment of Alzheimer's disease. This motivates the development of an ultra-sensitive sensing technique to resolve minimal differences of Mg^{2+} concentration between samples by using lab-on-a-chip based on single wall carbon nanotubes (CNTs).

Lab-on-a-chip is expected to bring major changes in the medical diagnostic field by providing compact sensors capable of detecting extremely low concentration of analytes. The unique physical properties of CNTs make them ideal candidates for using them as electrical/electrochemical detectors because of the high sensitivity of their electrical properties to minor changes in their environment.

Calmagite [1-(1-Hydroxy-4-Methyl-2-Phenylazo)-2-Naphthol-4-Sulfonic Acid] is the commonly used photometric indicator for Mg^{2+} in clinical laboratories to quantify Mg^{2+} in serum. A color change to red is observed upon calmagite Mg^{2+} complexation under basic pH which is directly correlated to the quantity of Mg^{2+}, but the colorimetric detection has poor sensitivity to low concentrations.

Calmagite was chosen to be used to detect Mg^{2+} because complexation interaction is ionic which can be precisely resolved by nanotubes instead of color change. Calmagite was electrically adsorbed onto dielectrophoretically trapped (non-oxidized) HiPCO carbon nanotubes through hydrophobic interactions. The electronic transport properties of pristine and conjugated nanotubes (with calmagite - before and after Mg^{2+} complexation) were measured.

Significant increase in resistance was observed upon calmagite adsorption onto CNTs.

Subsequent complexation of Mg^{2+} with the immobilized calmagite induced a notable decrease in resistance which is correlated to Mg^{2+} concentration. Another significant aspect is that the trapping conditions need to be optimized, because the changes in resistance upon Mg^{2+} complexation depends whether the trapped nanotubes are in single or bundle format. It has been observed that single nanotubes exhibit higher sensitivity than bundles.