Non-enzymatic selective detection of glucose based on a gold-decorated multi-walled carbon nanotube composite

David Branagan, Carmel B. Breslin
Electrochemistry and Materials Chemistry Research Group,
Department of Chemistry, National University of Ireland, Maynooth, County Kildare, Ireland.

Detection of glucose is of upmost importance in today's society with the present and ever increasing diabetes epidemic. Recent figures put the worldwide diabetes prevalence at a significant 6.4% of the global adult population. This is predicted to increase to 7.7% by 2030[1]. If not diagnosed, managed and treated, diabetes can result in many complications including heart disease, stroke, high blood pressure, blindness, kidney disease, amputation and other serious issues.

Accurate glucose detection is vital for diabetes management and although many sensors exist for this purpose, they can pose a number of problems; inaccurate glucose detection being their major limitation. Enzymes used such as glucose oxidase and glucose dehydrogenase exhibit degradation with pH, temperature and humidity changes. They also have short expiry dates, reproducibility issues and complicated fabrication issues. Another significant disadvantage is that low oxygen concentrations within the body can also hinder glucose quantification.

One way to possibly solve these problems and to provide more accurate glucose detection is to develop enzyme-less sensors, known as non-enzymatic glucose sensors. This is a relatively new approach to glucose detection that is gaining much attention as eliminating the use of enzymes could offer a more stable, accurate and possibly cheaper glucose detection[2].

In this study, non-enzymatic glucose sensors employing multi-walled carbon nanotubes decorated with gold particles were fabricated by direct reduction of gold from a gold salt onto sodium dodecylsulfate surfactant-solubilised carbon nanotubes. Specific acid treatments to carbon nanotubes prior to gold reduction showed great improvements in glucose sensing properties of the material. It was found that cycling the composite in an alkaline solution greatly improved the sensitivity of the surface to glucose in neutral media. Combining this sensor with a Nafion® membrane greatly increased the sensor's selectivity for glucose in the presence of the common interference molecule ascorbic acid. Selectivity was also evident amongst other commonly occurring interference molecules.

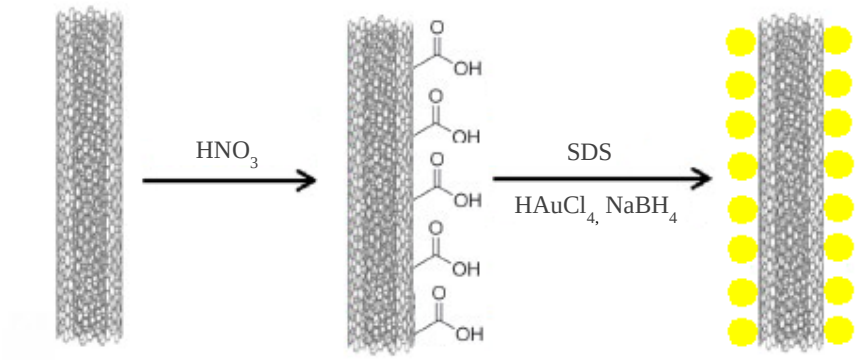

Figure 1. Schematic of gold reduction on surfactant-stabilised multi-walled carbon nanotubes.

1 Shaw J.E., Sicree R.A., Zimmet P.Z. (2010). Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Research and Clinical Practice*, 87, (1), pp. 4–14.

2 Park S., Hankil B., Taek D.C. (2006). Electrochemical non-enzymatic glucose sensors. *Analytica Chimica Acta*, 556, pp. 46-57.