Development of Enzyme Electrodes for Monitoring and Analysis of Food Analytes in the Food Industry*

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Introduction

Enzyme electrodes or known as biosensors have been used for years to detect the existence of chemical components or analytes in liquid phase such as glucose, glutamine, lactate, ethanol and glycerol.[1] Biosensors were developed due to the ability of a dedicated detection material (in this case enzyme) that sensitive to a specific analyte only. Theoretically, more than one analyte in the same liquid under test can be detected simultaneously when using multi-sensor detector. However, in order to gain maximum benefit from that achievement, it is necessary to integrate the sensors with high performance electronic signal processing system in which it can provide high measurement accuracy as well as offering portability feature due to the small size of today Integrated Circuit (IC) chips.

Materials and Methods

This research concentrates on the development of programmable signal processing system to be integrated with biosensors in order to improve the sensing efficiency and at the same time having the capability on multi-analyte detection. There are two versions of implementations; computer (PC)-based measurement unit and portable measurement unit. For both versions, signal-conditioning circuit is used to convert the incoming analog signals into digital data form. The digital data will then be processed to produce measurable information such as the concentration of analytes either in graphical display or numerical form.

Results and Discussion

In these implementations, eight sensors can be connected so that the measurement units can analyse up to eight analytes simultaneously. The software can provide flexibility in terms of managing the relationship between analyte concentration and electrical signal i.e. managing the measurement calibration.[2] The design of Digital Signal Processing (DSP) chip for portability purpose is based on the measurement protocols or procedures that have been established in the computer-based measurement unit. The DSP chip is basically to replace the general purpose PC into specific application i.e. in this case as a measurement unit. Also, the measurement unit physical size can be reduced significantly. Since the protocols are much dependent on parallel data processing, the DSP chip was designed based on VLIW (Very Long Instruction Word) architecture. The architecture consists of four 8-bit ALU (Arithmetic Logic Unit), two 8-bit multiplier, shifter, Data Address Generator, Register File, Program Memory, Data Memory and I/O (Input/Output) control blocks. The number of transistors involved in the DSP chip design is approximately 320,000.[3]

Conclusions

Based on these implementations, the basic requirements in developing electronic-based instrumentation that can detect analyse and monitor chemical components in liquid phase have been identified. These include measurement protocols for multi-analyte detection and, circuit design and software development specifications. The developed measurement units can provide value-added to the overall sensory system performance where high measurement accuracy can be achieved and has the feature of portability.

Benefits from the study

The ability to detect, analyse and monitor more than one chemical component simultaneously can be considered useful in providing better service for quality control applications in food industry. With this achievement, further works can be carried out to apply the measurement protocols based on the used of biosensors to other related fields such as medical, health and environment.

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