## Review of Designing an Information Processing Ware for a Diabetic Chip

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## Abstract

Miniaturization of clinical chemistry analyzers can empower research conducted to better understand, diagnose, manage, and cure diseases such as diabetes. For the last decade, we have been working on the design and development of miniaturized clinical chemistry devices, including a Diabetic Chip (diabetiChip). These devices measure a small array of analytes, are small, portable, fast, easy-to-operate, and inexpensive. The chosen analytical method for the diabetiChip uses bioluminescence, which is highly sensitive and specific, and is based on photon counting and specific enzymatic reactions. Bioluminescent reactions were intentionally chosen for analyzing metabolic reactions because they use some of the central nodes of metabolism, such as adenosine triphosphate. Operations of the diabetiChip's information processing ware are the focus of this paper; we show the feasibility of using a set of kinase-containing enzymatic reactions of a firefly bioluminescence-coupled glucose assay in designing the diabetiChip. We have developed and tested the feasibility of the glucose assay; the assay's analytical detection limits (before sample dilution) were 5–185  $\mu$ M. Uncertainty associated with reporting a 100  $\mu$ M concentration was about  $\pm 5 \mu$ M. The results show that an FFL bioluminescent-coupled glucose assay is promising in terms of reducing sample volume and cost. The concept of GlucoFaces<sup>TM</sup> in visualizing measurements of the diabetiChip is also discussed.

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## Introduction

Miniaturization of clinical chemistry analyzers can empower ongoing research in better understanding, diagnosing, managing, preventing, and curing diseases such as diabetes. For the last decade, we have been working on the design and development of clinical chemistry labs-on-a-chip (ChemChips), including a diabetic chip (diabetiChip), that measure a small array of analytes, are small, portable, fast, easy-to-operate, and inexpensive.<sup>1,2</sup>

In this article, we intend to provide background on the chip fabric (ChipWare) and the chemical analytical principle (ChemWare) of the diabetiChip; the reader is advised to refer to the cited references for further details regarding chip fabrication and assay lyophilization and immobilization. The focus of this paper is the development of the diabetiChip's information processing ware (InfoWare).

Abbreviations: (ATP) adenosine triphosphate, (ChemCD) clinical chemistry CD, (FFL) firefly luciferase, (PMT) photomultiplier tube, (RLU) relative light unit

Keywords: assay calibration, bioluminescence, Diabetic Chip, GlucoFaces<sup>™</sup>, information ware, lab-on-a-chip, simulation, visual display

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