Bio/Nano/CMOS interfaces for Remote Monitoring of Human Metabolism

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Integrated electrochemical Nano-Bio-Sensors [1] for diagnosis and/or treatment of patients with specific physiological conditions (e.g., heart, cardiovascular, cancer diseases) or convalescents is a key factor to provide better, more rationale, effective and ultimately low-cost health care also at home. The ultimate goal of improved health care on those subjects is the extension of the patients' autonomy, the possibility for auto-monitoring, the improvement of their comfort levels and their integration into everyday life. Some systems for on-line monitoring are available in the market. They use wearable devices (accelerometers, heartbeat monitoring system, etc). However, all these systems do not measure the human metabolism at molecular level (metabolites). The only available real-time, implantable/wearable systems for metabolic control are limited to glucose monitoring and used only for diabetic patients. However, electrochemical sensors may address so many other molecules, which have crucial relevance in human metabolism in chronic patients. So far, there are no available integrated nano-bio-systems for multi-metabolites, real-time, remote monitoring of the human metabolism. Thus, the aim of this tutorial is to present innovative concepts for multi-panel, highly integrated, fully implantable, remotely powered and real-time monitoring systems for human metabolism at molecular level. The considered metabolic molecules will be glucose, lactate, glutamate, ATP [2], and anticancer drugs as well as anti-inflammatory ones [3]. In case of drugs, the specificity of electrochemical sensors is improved at system level [4]. The proposed nanotechnology will be based on carbon nanotubes to improve the sensors performance [3, 5]. To pursue their detection, innovative VLSI solutions [6] are discussed including the system remote powering [7]. The new approach is demonstrated by showing Systems-In-Package with embedded System-On-Chip that integrate: (i) a sensors array for data acquisition; (ii) remote power and/or data transmission; (iii) nano-sensors; CMOS IC design; (iv) multi-panel metabolites detection. Systems applications are shown in the field of implantable devices with in-vivo experiments too [8] by including packaging issues [9] and monitoring in intensive care units [10].

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