Miniaturized biosensor arrays are attractive for parallel analysis of multiple parameters and targets. Overcoming the need for bulky bench-top instruments, miniaturized electrochemical sensor arrays enable many applications such as DNA testing, drug screening, antibody and protein analysis and biosensing. With advances in CMOS technology and microfabrication, it has become possible to integrate and miniaturize the sensors and CMOS instrumentation electronics on a single chip. Further integration with microfluidics leads to a more powerful lab-on-CMOS microsystem. However, such integration involves multidisciplinary knowledge of CMOS design, sensor technology, microfluidics and post-CMOS microfabrication and packaging. This dissertation seeks to overcome the challenges in post-CMOS fabrication and packaging and the size disparity between CMOS IC chip and microfluidics to enable lab-on-CMOS electrochemical sensing. A new, low-cost, CMOS compatible epoxy chip-in-carrier integration process was designed to package CMOS IC chip and expand the CMOS chip surface area. A new reliable surface polymer silver interconnect process was developed utilizing modified screen printing methods. The silver ink metal interconnects enable inexpensive electrical connections for CMOS ICs with improved yield due to their high thickness. An improved polymer silver interconnect process tailored to high density contacts was also invented by embedding interconnects in SU8 microchannels. For the first time, direct on-CMOS electrochemical measurements were achieved using an on-CMOS microelectrode array within on-CMOS microfluidic channels. This work defines a new lab-on-CMOS platform that enables on-CMOS electrochemical sensing within liquid-handling microfluidics.

Publications


