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Novel and Diverse Applications of Silicon Nanosensors and Imagers

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Summary

The application of nanotechnology to the realm of sensors fabricated with traditional CMOS techniques yields wide-ranging benefits. This presentation discusses two topics: CMOS-based biosensors and MBE-enhanced CCD and CMOS imagers.

First, self-assembled monolayers (SAM) can provide simple covalent links for attaching proteins to a silicon dioxide sensing surface of CMOS-fabricated sensors. The sensors can give real-time electronic detection of the interaction between the attached protein and proteins suspended in solution. In comparison with the microelectrode arrays, measurements are gathered through purely capacitive, non-faradaic interactions across insulating interfaces. By monitoring the film thickness of streptavidin capture, a sensitivity of 25 ng/cm^2 or 2 Å of film thickness was demonstrated. With an improved noise floor the sensor can detect down to 2 ng/cm^2/mV based on a measured calibration curve.

Second, bandstructure engineering by nanometer scale manipulation using molecular beam epitaxy has been developed to produce high performance imagers with 100% internal quantum efficiency in the UV/optical/NIR, low dark current, and highly uniform and stable response. In this process, called delta doping, a low-temperature (below 450 °C) growth technique is developed that incorporates a very high level of dopants in a thin, surface-confined layer, i.e., a delta layer, on the back of CCD or CMOS imager by molecular beam epitaxy (MBE). The MBE process, which can be applied post-metallization, will soon be scaled to high-throughput, wafer-level processing at JPL with an 8” MBE machine.