Wireless surface acoustic wave (SAW) sensors offer unique advantages over other sensor technologies because of their inherent ability to operate in harsh environments and completely passive operation, providing a reliable, maintenance-free life cycle. For certain SAW sensor applications the challenge is building a wirelessly interrogatable device with the same lifetime as the SAW substrate. The design of these application intensive sensors is complicated by the degradation of device bond wires, die adhesive, and antenna substrate. In an effort to maximize the benefits of the platform, this dissertation demonstrates wafer-level integrated SAW sensors that directly connect the thin film SAW to a thick film on-wafer antenna. Fully integrated device embodiments are presented that operate over a wide range of temperatures using different fabrication techniques, substrates, and coding principles.

The design of orthogonal frequency coded, OFC, RFID sensors is presented on the lithium niobate substrate at 915 MHz. The OFC concept was developed previously at UCF, and uses both frequency and time modulation to provide signal diversity and processing gain for the simultaneous operation of multiple sensors in a noisy environment. In a multi-sensor system, discrete time multiplexing of individual OFC sensors, which share bandwidth and independently change temperature, is ideal for accurate sensor detection. Coding techniques are demonstrated that shorten the overall SAW response length while preserving code diversity and bandwidth by utilizing a multi-track SAW configuration. The extraction of temperature and identification information from the wireless sensors is investigated. A coherence correlator was developed that processes sensor information in the frequency domain, and is compared to techniques previously published. The design of a meander dipole antenna is presented for use on the lithium niobate substrate. Various antenna fabrication techniques were used and wireless results are demonstrated over temperature.

In an effort to extend the operational temperature range of the OFC sensor SAW characterization was performed on the langatate substrate, which maintains piezoelectric operation up to its melting point of 1450 °C Fabrication techniques are investigated to extend SAW metallization lifetime at temperatures up to 1000 °C SAW coupling, substrate capacitance, velocity, and reflectivity are extracted at frequencies up to 915 MHz for various fabrication methods. The design of OFC sensors on langatate is presented, and results are demonstrated at 650 MHz. The design of a 650 MHz on-wafer dipole antenna is outlined and preliminary results are demonstrated over temperature. These integrated devices eliminate several locations of high temperature

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Approved for distribution by Donald Malocha, Committee Chair, on May 7, 2015.

The public is welcome to attend.