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Surface Acoustic Wave Resonators on Silicon

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The adaptation of surface acoustic wave resonator technology to a ZnO-on-Si layered medium is presented. Use of the (111)- and (100)-cuts of silicon as substrate permits resonators to be incorporated in monolithic silicon-based integrated circuits. Envisioned applications include on-chip oscillators, filters, and clock recovery tank circuits for use in high speed data communications. Several distributed reflector schemes are considered, including shorted and isolated metallic strips, as well as grooves etched in the ZnO layer by means of ion milling. In the case of etched-groove reflectors, a first-order velocity perturbation arises due to the dispersive nature of the layered medium; unique resonator design considerations result.

Prominent transverse modes arise in the etched-groove reflector arrays. The frequency spectrum of the resulting transverse mode resonances has been predicted. By coupling preferentially to the fundamental transverse mode, the deleterious effect of higher-order resonances on the frequency response can be eliminated. A novel transducer design is needed in the layered medium to accomplish this preferential coupling. Q-values in excess of 12,000 have been measured at 123 MHz, corresponding to a propagation loss of less than .7 dB/cm.

Resonators have been fabricated which utilize both Rayleigh and Sezawa modes, in which the reflector grating serves to convert efficiently between modes within a narrow frequency range. Greater rejection for out-of-band signals is expected due to the detuning between transducers of unconverted (delay-line) signals.

Control of resonator temperature characteristics has been accomplished by means of a thermally grown SiO_2 layer. Proper choice of SiO_2 thickness, in relation to acoustic wavelength, results in temperature stability comparable to that of ST-quartz. Finally, ageing data for hermetically encased resonators is presented.