Leaky SAW with reduced TCF on LT42/Silicon substrates

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SAW devices are now a standard for radio-frequency (RF) telecommunication filtering and several devices (filter, duplexer) are inescapable parts of RF stage of cellular phones. Therefore, a strong effort is still dedicated to reduce as much as possible their sensitivity to environmental parameter and more specifically to temperature. Several contributions have been developed for proposing composite wafers combining several materials to compensate the natural thermal drift of leaky surface acoustic waves (LSAW) on lithium niobate and lithium tantalate. For all the proposed technologies, solidly bounding heterogeneous materials is a quite complicated issue as thermal budget must be limited to avoid irreversible damage of the wafers.

A room temperature Au/Au bounding process has been developed at FEMTO-ST for the fabrication of composite wafers combining materials with very different thermoelastic properties, yielding innovative solutions for about-zero temperature coefficient of frequency (TCF) bulk acoustic wave devices. In the present work, this approach has been applied to (YX*l*)/42° lithium tantalate plates, bounded onto (100) silicon wafers and thinned down to 25 µm. The leading idea already explored by other groups as mentioned in introduction consists in impeding the thermal expansion of the piezoelectric material using silicon limited expansion. 2 GHz resonators have been built on such plates and tested electrically and thermally, first by tip probing. Although wave parameters was found only half the expected ones (coupling factor of about 4%) partly due to unoptimized electrode height, a dramatic reduction of the TCF is observed for all the tested devices, allowing to reduce the thermal drift of the resonators down to a few ppm.K^{-1} within the standard temperature range. This result has been confirmed using packaged devices in 3×3 mm² ceramic packages, yielding similar results and even temperature compensation for some of the tested resonators. Further work is engaged to propose a robust analysis of the frequency-temperature behavior of the device and to improve the resonators response by a proper choice of metal height to confirm the possibility to use these wafers for industrial applications.

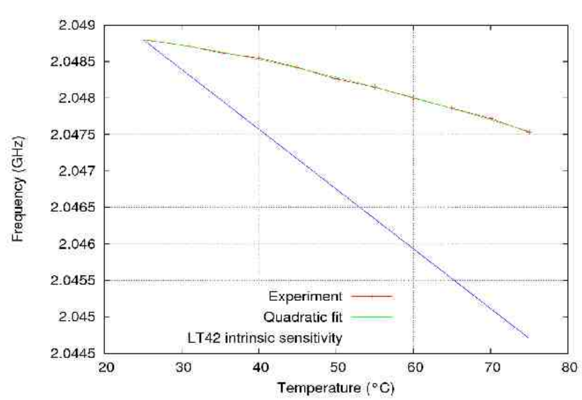

Fig. 1: Experimental measurements of thermal drift of 2 GHz resonators on LT42/Si composite wafers (-7 ppm.K^{-1} vs 40 ppm.K^{-1} for LT42 alone)

This work was partly supported by the POEM project granted by the French Research National Agency (ANR) within the P2N program.