Effects of a Plasma Etching Process on a Longitudinally Coupled Resonator Filter

L. Braun[a], E. Courjon[b], O. Franquet[a], W. Daniau[c], T. Baron[c], S. Ballandras[b]

[a] AR Electronique SAS, Besançon, France
[b] frec|n|sys SAS, Besançon, France
[c] FEMTO-ST, UMR 6174 CNRS-UFC-ENSMM-UTBM, Besançon, France

Email: loic.braun@femto-st.fr

The need of fabricating Surface Acoustic Wave (SAW) devices with an accurate frequency definition has lead SAW devices manufacturers to develop trimming processes. A current approach of trimming process widely used to decrease the frequency of SAW devices consists in etching the substrate between electrodes using an appropriate plasma. According to this principle, we have developed such a process using a standard reactive ion etching (RIE) machine, to trim narrow-band longitudinally-coupled resonator filters (LCRF) operating at gigahertz-frequencies. Such filters are based on double-resonance structures exploiting the exchange of acoustic energy between two transducers through a coupling cavity via evanescent waves. The trimming process consists in measuring the passband on the filter for the estimation of the offset between the targeted and effective central frequencies. The amount of substrate to be etched is then deduced using abacuses computed using our coupled finite element/boundary element analysis tool. The application of the process to the devices for different durations shows a rate of less than 20 ppm of frequency per second. Considering such an etching rate, the process reveals accurate enough for meeting specified frequencies with an accuracy of about 50 ppm. Figure 1 illustrates the trimming results, demonstrating the preservation of the transfer function. A deeper analysis of the transfer function shows however a diminution of the bandwidth and an enlargement of the stop-band in the transducers and in the coupling reflectors, which corresponds to a rise of the reflecting coefficient conforming theoretical predictions. At last, this rise can induced significant losses for frequency shifts larger than 1000 ppm, demonstrated theoretically and experimentally. For a frequency shifts smaller than 100 ppm, the trimming process yields an almost linear correction relation between the etching depth and the relative frequency shifts, conferring a very trustful character to the process. Finally, the very interest of the approach is the possibility for single (or very few) filter trimming once bounded into standard ceramic packages.

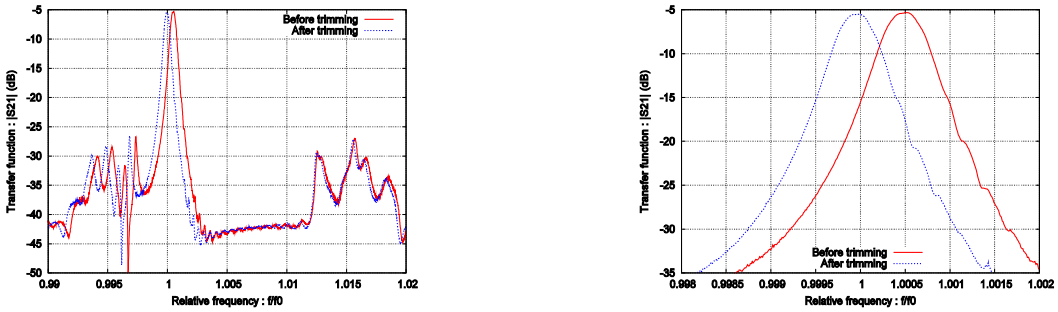

Figure 1: Example of trimming of a LCR filter for adjusting the central frequency with accuracy near 50 ppm (a) wide band plot (b) zoom near the filter pass band