Temperature impact on Laterally eXcited Bulk Acoustic Resonators

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The high demand for high frequency and large bandwidth filters for telecommunication has sparked a large interest for piezoelectric resonators made of single crystalline materials. Lithium Niobate (LiNbO3) laterally excited Bulk Acoustic Resonators (XBARs) employing the asymmetric A1 mode allow for large coupling at frequencies around 5GHz. We want to investigate the effect that cryogenic temperatures have on such resonators to assess their potential for applications in harsh environments such as Space.

We fabricated XBARs made of 400nm of Z-cut monocrystalline Lithium Niobate with Aluminum interdigitated electrodes, with a second metal layer for pads, to reduce the contact resistance. The resonators were then probed using a Rohde & Schwarz ZNB20 Vector Network Analyzer connected to a Lakeshore CRX-4K probe station with GSG probes, over a temperature range from 4.5K to 290K, kept under vacuum. To improve the thermal contact the chip was placed on the probe station sample holder with a layer of Apiezon N-grease. A GGB CS-5 calibration kit was placed on the sample holder together with the chip to calibrate the probes for each temperature.

As shown in Fig. 1 (a) at low temperature the resonance frequency of an XBAR increases and the coupling decreases (admittance plots shifted for better readability). This can be explained qualitatively with the temperature stiffening effect of LiNbO3, while electromechanical coupling remains stable. Further investigation can trace the Temperature stiffness coefficient and its dependency to the angle of the crystal cut.

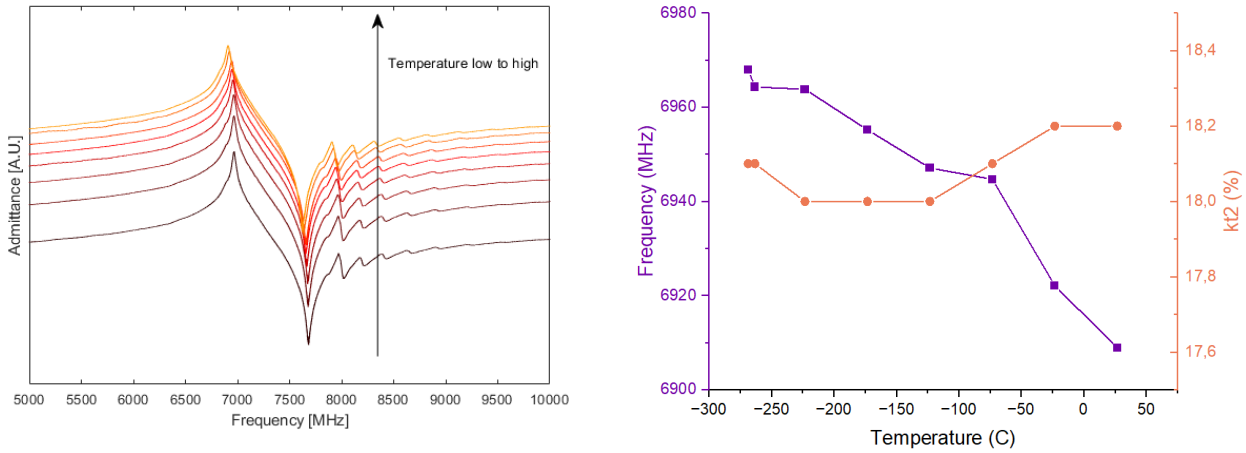

Fig. 1: Admittance curves showing stiffening at lower temperatures and evolution of the main mode resonance frequency and piezoelectric coupling against temperature.