Solidly mounted YBAR on high-velocity substrate

Victor Plessky[1, 3], Naiqing Zhang[2], Nan Xu[4], Seniz Esra Küçük [4], Luis G. Villanueva[4]

[1] NanoRF Sàrl, Lausanne, Switzerland
[2] Huawei Technologies Co., Ltd., Shanghai, PR China
[3] Huawei Technologies Oy (Finland) Co.Ltd, Helsinki, Finland
[4] Advanced NEMS Laboratory, EPFL, Lausanne, Switzerland

Email: viktor.plesski@huawei.com

Recently proposed SH1 plate resonator (YBAR [1]) demonstrates a record high coupling – frequency gap between resonance and anti-resonance (RaR) of about 19%[2]. Here we propose a new version of this device solidly mounted on a bulk substrate with high acoustic velocity[3]. That makes the device more robust mechanically and improves its power handling capability.

The device comprises a periodic structure of relatively narrow thin Film Bulk Acoustic Resonators (FBARs, but with shear SH1 modes), solidly mounted on high velocity substrate (see inset in the Fig.). The single resonators are separated by deep tranches in LN. Periodically opposite phase RF voltage is applied to the top electrodes, while the bottom electrode remains floating. The bulk waves excited by the electrodes are bouncing up and down in the (LN) resonator layer and acoustic waves are not radiated into the substrate, if the pitch is sufficiently small, exponentially decaying in the depth of substrate.

Most suitable would be the diamond substrate. In this case the 5GHz resonators can be obtained with pitch p<1.2 µm suitable for manufacturing with optical lithography. In experiments we use SiC substrate allowing 5GHz resonators with the pitch around 0.7 um. Further reduction of losses and increase of RaR coupling parameter can be achieved optimizing the floating bottom electrode thickness and the thickness of the SiO_2 between the floating electrode and the SiC substrate, although the coupling remains lower than in suspended YBAR[1].

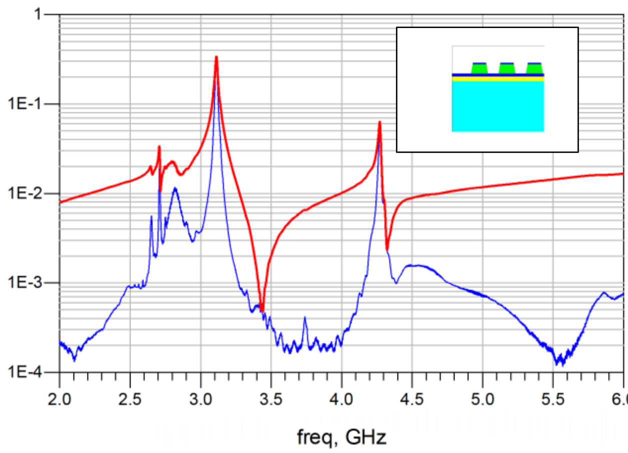

Fig. Measured admittance curve: abs(Y) shown in red and Re(Y) in blue. LN (shown in green) thickness 600nm, bottom electrode (blue) 50nm, SiO2 layer 300nm thick..

The technology for manufacturing this device operating at 3.5 GHz has been developed and will be presented by Nan Xu *et al* in a parallel paper. Further development is ongoing with the goal to improve Q-factors and to increase frequency to 5 GHz.

---

[1] V. P. Plessky, J. Koskela, and S. Yandrapalli. "Crystalline Y-cut Lithium Niobate Layers for the Bulk Acoustic Wave Resonator (YBAR)." In 2020 IEEE International Ultrasonics Symposium (IUS), pp. 1-4. IEEE, 2020.

[2] S. Yandrapalli, *et al*, (2023). "Toward Band n78 Shear Bulk Acoustic Resonators Using Crystalline Y-Cut Lithium Niobate Films With Spurious Suppression", Journal of Microelectromechanical Systems. 2023.

[3] V. Plesski, "An acoustic resonator solidly mounted on a high acoustic velocity substrate", Patent Appl. WO2023169653A1, 2023.