A comparative study of LGS coefficient set accuracy assessed by experiments

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Surface acoustic wave (SAW) resonators built on Langasite have revealed capable to withstand temperature in excess of 900°C and demonstration of wireless interrogation of packaged sensors up to 700°C has been achieved for several tens of hours. These promising results indicate the possibility for developing high temperature sensors for harsh environment purposes. They also emphasize the need for effective material coefficients allowing for designing SAW resonators with a high level of confidence in the prediction of the device electrical response and more of its temperature coefficient of frequency (TCF). Several data set have been published for LGS, yielding a wide range of prediction capabilities but also a significant level of data dispersion yielding more or less robust evaluation of the effective properties of Rayleigh waves under periodic metal gratings. The achievement of the SAWHOT project has yield numerous experimental results of SAW resonators on various LGS crystal cuts, yielding a consistent data base for a comparative evaluation of the SAW characteristics prediction quality provided by the above-mentioned set of LGS constants (elastic, piezoelectric, dielectric and thermal expansion fundamental coefficients as well as effective thermoelastic constants).

In the proposed paper, this material is used to assess the accuracy of the published data sets and more specifically their capability to predict measured TCF for several crystal cuts supporting Rayleigh waves, namely (YX), (YX*t*)/32°, (YX*lt*)/48.5°/26.7° and (YX*lt*)/-68°/31°. In addition the (YX*lt*)/-68°/90° cut supporting surface transverse waves (STW) has been considered to extend the validity of the data sets to shear horizontal wave polarization. Data from Kaminskii (1983), Ilyaev (1986), Silvestrova (1993), Sakharov (1995) and Bungo (1999) have been used to systematically evaluate their capability to predict first and second order TCF. The results are reported in the paper, showing that among all these data sets, the one by Silvestrova provides the closest-to-experiment predictions considering the exploited material for the above-mentioned project whereas Bungo coefficients reveals rather accurate for room temperature SAW response prediction. Considering the experimental data set used to asses the tested coefficients, the authors finally propose a combination of data set allowing for accurate prediction of the device behavior at room and elevated temperature. Effective thermoelastic constants are finally slightly modified to best fit second order TCF. The completeness of the proposed data set is discussed as a conclusion.

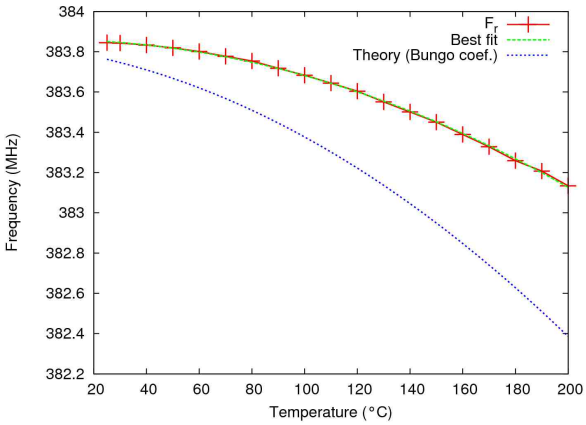

Fig. 1: Example of experimentally assessed TCF prediction using Bungo thermoelastic data

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