Reliability study of THz Schottky mixers and HBV frequency multipliers for space applications

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Abstract—We report status and current results of the preliminary reliability study on 300 GHz InP heterostructure barrier varactor diode multipliers and 1200 GHz GaAs Schottky diode mixers. Both types of diodes are monolithically integrated with circuits and were processed on 3" InP and GaAs wafers respectively using established III-V processing. We will present results on thermal step-stress tests up to 300ºC, indicating the operational temperature limitations of the devices. Also, the analysis of the accelerated lifetime testing (1000h) will be discussed.

INTRODUCTION

There is a need for efficient and reliable THz sources and heterodyne receivers operating in the sub-millimetre wave band above 300 GHz for future space science missions and earth observation instruments. The sub-millimetre wave regime allows the study of different meteorological phenomena such as water vapor, ice and water content in clouds, and ice particle sizes and distribution, which are important parameters for the hydrological cycle of the climate system and the energy budget of the atmosphere or even explore outer space. Several space bound exploratory missions have carried instrumentation operating in this frequency range. Besides of high level of integration required for operation at THz range, the components utilized for space instruments, must be highly reliable, i.e. perform as expected throughout its planned lifetime. It is therefore important to conduct reliability tests on device/component level to ensure projected performance in future missions. This work describes the preliminary reliability testing of 300 GHz heterostructure barrier varactor diode frequency multipliers [1] and 1200 GHz Schottky diode mixers [2] fabricated on 3" wafers.

The reliability tests start out with step-stress tests of temperature, dc bias and RF. These tests will give us the limits T_{max}, V_{max} and RF_{in} which will be used as boundary conditions for the followed accelerated lifetime tests. Fig 1 shows the progression of the current-voltage relationship of a heterostructure barrier varactor during a temperature step-stress test ranging from 120 ºC to 300 ºC.

The overall aim of these tests is to fully understand the limitations of our devices so that we can improve, through augmented fabrication, as well as better predict their behavior to prove their reliability as state-of-the-art, THz workhorse devices.

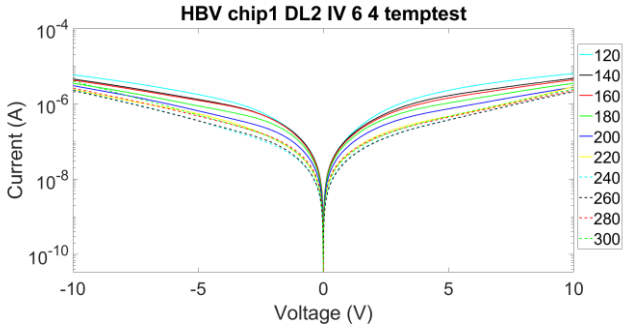

Fig. 1. 24h temperature step-stress test result (120-300 ºC) on heterostructure barrier varactor diodes chips fabricated at MC2, Chalmers.

ACKNOWLEDGEMENT

This work was performed in part at Myfab Chalmers in a project funded by European Space Agency within General Support Technology Program – "HBV and Schottky components for Space".

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