Monolithic approach of terahertz HBV-based multipliers

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Introduction: Heterostructure Barrier Varactors have demonstrated excellent performances in the millimetre wave spectrum with well defined advantages in terms of (i) C-V symmetry, (ii) lack of bias voltage and (iii) possibility to epitaxially and planar integrated several barriers in series [1]-[3]. The main drawback related to a low semiconductor barrier height for AlGaAs-based devices, with respect to the metal Schottky counterpart, has been overcome with the fabrication of high performance InP-based heterotructures solving by this way the device-related problems. In this paper, we addressed the circuit-related issues in connection with the fabrication of monolithic devices aimed at operating at Terahertz. This work is carried out in the framework of an ESA contract with the University of Lille as prime, where the epilayers are grown and where monolithic devices are fabricated on the basis of full wave analyses and advanced technologies (MBE, e-beam, RIE,...).

Integrated Circuit's approach and related issues: There are several advantages associated with the fabrication of monolithic devices. First of all, the fact to work under fixed tuning avoids the tedious mounting of the devices with the benefit of a better knowledge of the device embedding. At last, this permits to decrease dramatically the diode series resistance, which impacts dramatically the frequency capability of the device, notably by means of vertical integration techniques. Figure 1 thus shows a scanning electron micrograph of a monolithic circuit fabricated at IEMN. The active devices integrate four barriers (two during the growth and two by planar integration as shown in inset) and have demonstrated state-of-the-art performance in the upper part of the millimeter wave spectrum at 288 GHz.

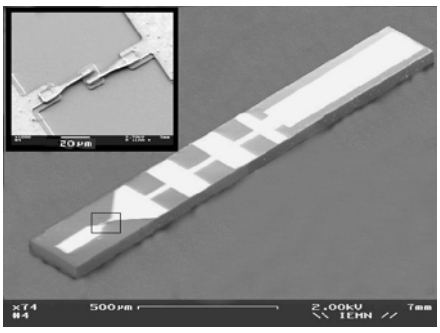

Fig. 1: SEM view of a device monolithically fabricated onto a quartz substrate

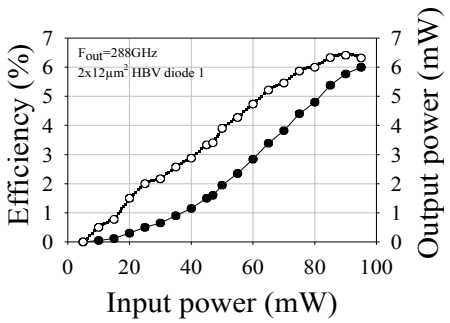

Fig. 2 : Performance of a 288GHz tripler

Upper operation frequencies targeted, that is to say between 500 GHz and 1 THz, require to further study the electromagnetic behaviour of propagation media in order to avoid multimoding by mode matching [4] and to limitate the overall losses with fixed tuned matching circuit, mainly at the input of the non-linear diode. From this side, membrane-like approach and thin film BCB technologies are currently investigated in our laboratory.

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