Diamond-Substrate Schottky Diodes for high-power MM-wave Multipliers

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Abstract — Relatively high power, in the range maybe of 1W, is desired for many applications at MM/SubMM waves, including active imaging, high bit-rate data transmission, and Inferior chains for LO-sources in THz heterodyne receivers. Moreover, most of "real-live" applications impose severe requirements to THz sources like compactness, reliability, and price. Many R&D groups worldwide address these requirements but the current state-of-the-art devices still do not fulfil all requirements.

The most practicable approach nowadays to generate power above 100GHz is frequency multiplication approach based on Schottky diodes. However, power-handling capability of multiplier modules is still a severe limiting factor for obtaining high power at MM/SubMM-waves by frequency multiplication. For instance, state-of-the-art MM-wave doubles perform about 25%-30% efficiency, but their maximum input power-handling capability is usually limited in the range of 200mW. This limitation basically defines maximal achievable output power of about 50-60mW.

The limiting factor for maximal power-handling capability is twofold. On one hand, this is limited electrically, basically due to breakdown voltage of Schottky varactors. On another hand, power-handling capability is thermally limited by inferior heat dissipation approaches.

ACST has recently modified their Film-Diode process for fabrication of high-breakdown varactor diodes on transferred Diamond substrate. The breakdown voltage of ACST varactor diodes is highest-possible for any particular doping concentration, and is close to theoretical limit. On another hand, CVD-diamond is known to be one of the best thermal conductive dielectrics in the nature. Therefore, combination of these two aspects in ACST varactor diodes suggest considerably-increase of maximal power-handling capability, which is key-factor for achieving high-efficiency high-power MM-wave frequency multipliers.

This contribution will address the above challenges and solutions for MM-wave frequency multipliers. Finally, preliminary results shall be presented on a 135-160GHz doubler, which survives input power of up to 750mW and provides output power more than 150mW. On Authors knowledge this is the highest power achieved from a single device without use of power combining approach.