Nanoscaled RF to DC rectifiers based on ballistic transport at room temperature

Lukasz Bednarz [a,*], Rashmi [a], Benoît Hackens [b], Herve Boutry [b], Vincent Bayot [b], Isabelle Huynen [a]

[a] *Microwave Laboratory, Université catholique de Louvain, Place du Levant 3, 1348 Louvain-la-Neuve, Belgium.*

[b] *Microelectronics Laboratory, Université catholique de Louvain.*

The last advances in nanotechnology allowed fabrication of nanometer-size electrical devices showing novel nonlinear electronic properties unknown in typical-sized devices. Especially two-dimensional electron gas systems (2DEG), like InP based InAlAs/InGaAs heterostructures are very interesting from an application point of view, thanks to their full compatibility with high electron mobility transistor (HEMT) technology. Electron mean-free-path (L_e) in these structures is larger than 200 nm at room temperature, which means that nanodevices with characteristic dimensions L_c smaller than L_e are in the ballistic regime. The three terminal Y-branch junction (YBJ) is one of the most promising nanostructures as regards future applications, thanks to its strong nonlinear and switching properties. Nonlinear characteristics of YBJ can be used for generating direct current (DC) and higher order harmonics from high frequency (HF) signal. Room temperature DC and broadband HF measurements of a Double Y-branch junction are presented and discussed. Nonlinear DC characteristics of the devices at room temperature are observed and HF to DC conversion up to 50 GHz at room temperature is presented. Small-signal equivalent circuit of YBJ is proposed. The HF to DC conversion efficiency degradation is found to be due to parasitic crosstalk capacitance between the 2DEG access reservoirs of the device. To overcome those problems, and increase operation frequency above 50 GHz, designs of new topologies are in progress.

* Corresponding author. Tel. +3210478106. FAX +3210478705.
Email address: bednarz@emic.ucl.ac.be (Lukasz Bednarz).