Stuttgarter Physikalisches Kolloquium

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Towards femtoseconds on-chip electronics

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Abstract

To combine the advantages of ultrafast femtosecond optics with an on-chip communication scheme, optical signals with a frequency of several hundreds of THz (i.e. photon energy of ~1 eV) need to be down-converted to coherent electronic signals of GHz or less. In the best case, this down-conversion needs to be compatible with the 10nm footprint of modern transistor electronics.

We demonstrate that femtosecond optical pulses in the near-infrared (NIR) can drive non-linear electronic pulses in nanoscale circuits with a bandwidth of up to 10 THz [1]. The corresponding THz transients propagate in on-chip THz-stripline circuits on a macroscopic, millimeter scale. In particular, we exploit plasmonic photoswitches based on tunneling barriers in nanoscale metal junctions to drive the transients. The non-linear ultrafast response is based on a combination of multi-photon absorption and quantum tunneling, and gives rise to a field emission with ballistic electrons propagating across the nanoscale junctions. Our results pave way towards femtosecond electronics in waferscale circuits.

Moreover, we will demonstrate how a similar THz time-domain spectroscopy can be utilized to detect the ultrafast optoelectronic dynamics in nanoscale materials, including 2D materials and topological insulators.

[1] C. Karnetzky, P. Zimmermann, C. Trummer, C. Duque Sierra, M. Wöhrle, R. Kienberger, A. W. Holleitner, in press (2018).