# Thermotronics - Cuircuits for Thermal Management with Photons

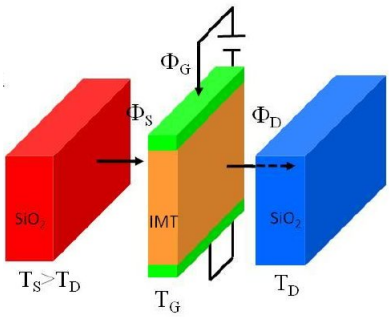
S.-A. Biehs[1] and P. Ben-Abdallah[2]

[1] *Institut für Physik, Universität Oldenburg, Germany*

[2] *Laboratoire Charles Fabry, UMR 8501, Institut d'Optique, CNRS, Université Paris-Sud 11, 2, Avenue Augustin Fresnel, 91127 Palaiseau Cedex, France*

The control of electric currents in solids is at the origin of the modern electronics which have revolutionized our daily life. The transistor introduced by Bardeen and Brattain [1] in 1948 is undoubtedly one of corner stones of modern information technologies. Such a device allows for switching, modulating and even amplifying the electric current and is therefore one of the main building blocks of a computer. Other well-known basic building blocks of a computer are diodes and memories, for instance. Surprisingly, similar devices which would allow for controling the heat current instead of the electric current are not so frequent at all in our every-day life.

In this presentation we first introduce the basics of thermal radiation at the nanoscale using a Landauer-like approach [2,3]. In particular we will discuss the major impact of surface phonon polaritons on the radiative heat flux for distances smaller than the thermal wavelength (the near-field regime) which is one of the major heat flux channels for nanoscale photonic heat transport leading to so-called super-Planckian radiation.




Sketch of a thermal transistor.

Finally, we will discuss the possibility to develop a thermal analog of the fundamental building blocks for controlling the heat current carried by thermal photons in the near- and far-field regime. In particular, we will introduce the concepts of a thermal diode [4], thermal transistor [5] and a thermal memory [6] based on phase-change materials. As an outlook we will give a brief overview of future concepts of further thermal circuit devices such as thermal heat flux splitters [7].

References :

[1] J. Bardeen and W. H. Brattain, Phys. Rev. **74**, 230 (1948).

[2] S.-A. Biehs, E. Rousseau, and J.-J. Greffet, Phys. Rev. Lett. **105**, 234301 (2010).

[3] P. Ben-Abdallah and K. Joulain, Phys. Rev. B. **82**, 121419(R) (2010).

[4] P. Ben-Abdallah and S.-A. Biehs, Appl. Phys. Lett. **103**, 191907 (2013).

[5] P. Ben-Abdallah and S.-A. Biehs, Phys. Rev. Lett. **112**, 044301 (2014).

[6] V. Kubytskyi, S.-A. Biehs, and P. Ben-Abdallah, Phys. Rev. Lett. **113**, 074301 (2014) PRL Editor's suggestion and Focus Physics **7**, 85 (2014) .

[7] P. Ben-Abdallah, A. Belarouci, L. Frechette, and S.-A. Biehs, Appl. Phys. Lett. **107**, 053109 (2015).