Thermodynamic Characterization of LED Lighting Systems

Supervisor: Prof. Dr.-Ing. Stephan Kabelac, Institute for Thermodynamics
Co-Supervisor: Prof. Dr.-Ing. Eduard Reithmeier, Institute of Measurement and Automatic Control

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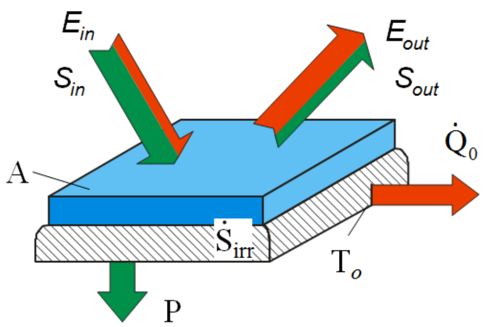
In this basic research subproject LED lighting systems shall be thermodynamically analyzed and evaluated regarding their capability of converting electric energy into radiation energy. Electromagnetic radiation appears as one form of energy afflicted with entropy, similar to heat flows. Therefore, energy conversion at and with LED systems is subject to thermodynamic limits, analogous to the Carnot efficiency regarding the conversion of heat energy into work. The entropy content of electromagnetic radiation energy depends on the spectral distribution and the solid angle distribution of the electromagnetic waves [1]. Monochromatic laser radiation is free of entropy. Thermal blackbody has the maximum entropy coming with an energy. Therefore, LED light sources with any spectral distribution represent a perfect opportunity to provide radiation energy flows with tailored entropy shares. If, for example, the spectral distribution of the incident light can be adjusted to the spectral optical reflection behavior of the receiving surface, an approximate reversible absorption (conversion of radiation energy into thermal inner energy) will be possible.

The aim of this project is the identification and validation of thermodynamic tools by basic experiments in order to describe the efficiency of energy conversion in LED lighting systems. In the beginning, a simple and well characterized opaque surface with known reflection behavior and well defined thermostated behavior shall be irradiated with light from an also well characterized LED light source in order to allow the verification of the calculated energy and, especially, entropy balances for this simple system. In the following the modified setup should be used to analyze the energy conversion of tailored LED irradiation on photovoltaic cells.



Energy and entropy fluxes at a general radiation energy conversion device, as, for example, a photovoltaic cell.

[1] Kabelac, S.; Conrad, R.: *Entropy Generation During the Interaction of Thermal Radiation with a Surface.* Entropy 14 (2012), 717-735

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