Modelling of optimized TE gradients for energy conversion and cooling

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Graded and segmented thermoelectric elements have been studied for long, aiming at improving the performance of thermogenerators which are exposed to a large temperature difference. However, it has been shown that simply adjusting maximum *ZT* in each segment of a stacked or graded TE element is not a sufficient rule to maximize thermoelectric device performance.
An overview shall be given on strategies to improve the performance in different scenarios: TEG operation in maximum efficiency and maximum power modes, cooler operation in maximum cooling power, maximum C.O.P., and maximum temperature difference modes, respectively. Whereas local criteria for performance optimization have been formulated in the past for most of these cases, working out a similar criterion for maximum cooling power of a Peltier device faces analytical difficulties. Recent numerical experiments have brought evidence that a dramatic increase of the maximum temperature difference within limited *ZT* can be achieved by suitably chosen gradient shape whereas an analytic approach to this problem is still missing.
Precise numerical calculations for performance estimation of TE devices based on a one-dimensional continua-theoretical model enable to calculate accurate profiles of temperature, potential, and energy flux along segmented and graded TE elements with arbitrarily chosen profiles of the TE properties.

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