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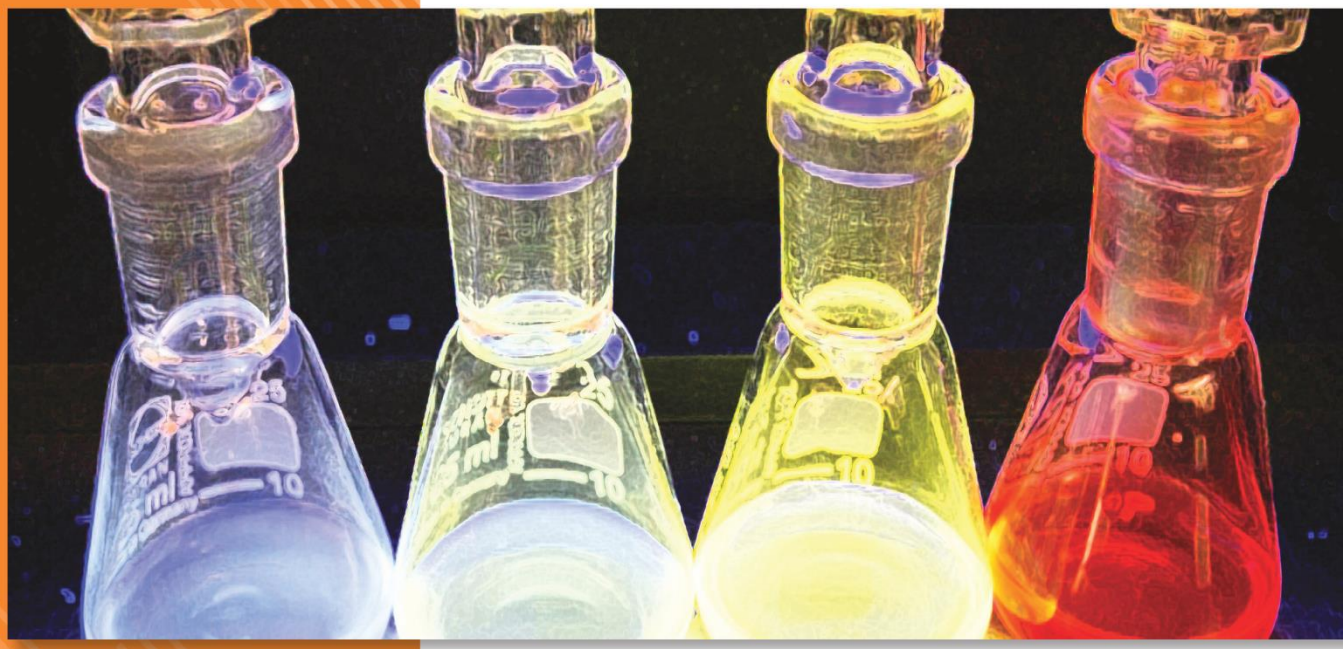

Nanoscale heat transfer in Si membranes and phononic crystals

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15. Oktober 2018
16:00 Uhr
Campus Freudenberg
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Thermal transport in free-standing silicon membranes has attracted increasing attention to advance the understanding of how the volume-to-surface ratio [1], phononic crystal periodicity, disorder [2] and air convection [1] impact thermal energy propagation. We will discuss the physical regimes under which the dominance of each of the above takes place.

Our experiments were performed over a range of 300 to 1000 K [1] in purpose-designed 2D phononic crystals in the form of free-standing SOI membranes patterned by electron beam lithography and dry etching [3]. The band structure of 2D phononic crystals was calculated using FEM [4], the experimental methods include Brillouin scattering, pump-and-probe picosecond acoustics [2] and laser Raman thermometry [5].

One of the main parameter is found to be the surface to volume ratio, which is affected by air convection losses and by the shape of the necks of the phononic crystal design. Furthermore, the realisation of solid-solid phononic crystals points to the possibility to tailor multiple ways of storing and retrieving energy in these oscillators when coupled to Lamb waves.

[1] B. Graczykowski et al, Nature Comms **8** 415 (2017)
[2] M. R. Wagner et al, Nano Letters **16** 5661 (2016)
[3] M. Sledzinska et al., Microelectronic Eng, **149**, 41 (2016)
[4] B. Graczykowski et al., Phys. Rev. B 91 075414 (2015)
[5] E. Chavez Angel et al., Appl. Phys. Lett. Materials 2 012113 (2014); J. S. Reparaz et al., Rev. Sci. Instruments 85 034901 (2014).

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