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Thermal conductivity measurements[1]

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The thermal conductivity κ, the Seebeck coefficient S and the resistivity ρ enter the expression for the dimensionless figure-of-merit ZT,

$$ZT = \frac{S^2 \cdot T}{\kappa \cdot \rho} \tag{1}$$

which characterizes a material's efficiency concerning thermoelectric power generation or cooling. Thus, by lowering the thermal conductivity, ZT can be enhanced. By introducing rattling modes or increasing the contribution of grain boudaries, the phonon thermal conductivity can be lowered.

Here we present thermal conductivity measurements on meltspun $Ba_8Ga_{16-x}Ge_{30+x}$ clathrates [1] as well as on nanostructured polycrystalline $(SrTiO_3)_{1-x}(SrCO_3)_x$ samples, synthesized by the evaporation induced self-assembly approach used in Ref. 2. The melt spinning technique [3, 4] can produce $Ba_8Ga_{16-x}Ge_{30+x}$ in a metastable state, where x can be varied continuously from negative to positive values, resulting in both p- and n-type materials. The temperature dependent thermal conductivity of the p-type ($x = -0.1$) compound shows no maximum at low temperatures, which might be explained by strong phonon charge carrier coupling. Steady-state heat-flow experiments on meltspun $Ba_8Ga_{16-x}Ge_{30+x}$ flakes had to be carried out by means of a parallel thermal conductance technique to mechanically stabilise the 20 μm thin samples.

In comparison to single crystalline $SrTiO_3$, the thermal conductivity of nanostructured polycrystalline $(SrTiO_3)_{1-x}(SrCO_3)_x$ is found to be reduced by a factor of 10. The substitution with $SrCO_3$ was done to lower the thermal diffusivity. A systematic dependence of the diffusivity on the $SrCO_3$ content could not be observed.

A new thermal conductivity setup based on the 3ω-method [5] is also presented. Such a setup is particularly well suited for thin film samples. In comparison to the standard steady-state heat-flow technique, thermal radiation and heat loss in the temperature measuring probes hardly affect the measurement. Thus, thin samples with low thermal conductivity can be measured.

[1] S. Laumann et al., *J. Mater. Res.*, **26**, No.15, (2011).
[2] X. Fan et al., *Chem. Mater.*, **22**, No.4, (2010).
[3] S. Paschen et al., *J. Cryst. Growth* **310**, 1853, (2008).
[4] A. Prokoviev et al., Utility patent AT: 10749 U1 2009-09-05, DE: 20 2008 006 946.7, patent applications U.S.: 12/231,183, JP: 135994/2008.
[5] D. G. Cahill, *Rev. Sci. Instum.* **61**, No.2, (1990).

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