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Operating Characteristics of a Microfabricated Phonon Spectrometer RICHARD ROBINSON, JARED HERTZBERG, OBAFEMI OTELAJA, MAHMUT AKSIT, Department of Materials Science and Engineering, Cornell University — Phonon scattering exhibits a strong influence on the thermal properties of nanostructures. By promoting phonon scattering at surfaces and interfaces, a nanostructured thermoelectric material may achieve reduced thermal conductivity and enhanced thermoelectric efficiency. While phonons over a wide frequency range contribute to energy transport, thermal conductivity measurements capture only their combined effect. However, a window into phonon transport in nanostructures at specific frequencies could provide unique information and also serve as a crucial test platform for phonon transport theories. To this end, we have constructed a microfabricated phonon spectrometer. At a temperature of 0.3K, a superconducting tunnel junction locally generates non-thermal distributions of phonons and transmits them through adjacent silicon micro- and nanostructures.[1] We employ modulation techniques to select narrow frequency bands of phonons at frequencies up to hundreds of GHz. This prototype phonon spectrometer achieves phonon frequency resolution as low as $\sim$10 GHz, more than an order of magnitude lower than comparable thermal methods. We describe the other key parameters of this technique: spatial resolution, frequency range, dynamic range, signal-to-noise ratio and calibration methods. This work was supported in part by the National Science Foundation under Agreement No. DMR-1149036.

[1] J. B. Hertzberg et al, Rev. Sci. Inst. 82, 104905 (2011)

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