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Effect of photo-excited carriers on the thermal conductivity of silicon JIAWEI ZHOU, DOUG SHIN, ALEXEI MAZNEV, Massachusetts Inst of Tech-MIT, BOLIN LIAO, California Institute of Technology, KEITH NELSON, GANG CHEN, Massachusetts Inst of Tech-MIT — Thermal conductivity is a critical quantity for heat dissipation in microelectronic and optoelectronic device, and has also been widely explored to enhance material's thermoelectric efficiency. Among these cases, the thermal transport often happen when the electron carriers also exist, which are either excited by light or introduced by dopants. Understanding how these carriers affect the thermal transport can lead to better device designs or material optimizations. Despite past modeling work and recent experiments on the interaction between electrons and the heat carriers - phonons, it is still not clear how the carriers affect the thermal conductivity in a quantitative way, mainly because the dopants will introduce defect scattering which is hard to separate from the effect of carriers alone, while the photo-excited carrier density is usually limited by the pulse energy and not significant enough to impact the thermal transport. In this work, we use the transient thermoreflectance set up with a high pulse energy to monitor the thermal conductivity change in silicon as a function of generated carrier density. We show that, the moderately generated carrier density has a clear influence on the thermal conductivity. These results also demonstrate the ability of utilizing the electron-phonon coupling to tune material's thermal transport. This work is supported by DOE EFRC (Grant No. DE-SC0001299).

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