

ナノスケール・サーマルマネジメント基盤技術の創出
2019年度採択研究代表者

2022年度
年次報告書

ヴォルツ セバスチャン

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二次元表面フォノンポラリトンの熱伝導制御

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研究成果の概要

Surface Phonon-Polaritons SPhPs contribution to heat flux in a SiN nanomembrane was measured between 300K and 400K, while previous and less accurate results revealed SPhPs at higher temperatures only. Phonons or vibrations propagate diffusively in nanomembranes. The here highlighted quasi-ballistic heat conduction expresses the presence of SPhPs and their long propagation lengths (1).

We have opened a new space in the field of polariton heat conduction by theoretically proving that metal surface plasmon-polaritons (SPPs) also carry heat substantially (2).

Theoretical prediction of SPhPs guiding in a planar vacuum cavity has revealed a substantial polariton heat flux at millimeter scale (3).

The rectification concept uses asymmetry between a trilayer and a pristine film to prove a SPhP diode effect. Guided SPhPs heat flux should be activated in the trilayer but not in the pristine one, hence providing an asymmetric thermal conductance in the gap between the two structures. Devices have been fabricated and measured.

As polaritons carrying heat spread over a large frequency range, a Cr/Au 10/100 nm thick structure based on multiple bow-ties was fabricated on a SiN 50 nm-thick membrane. Metallic bow-ties are heated on their periphery via Joule heating and focus broad range plasmon heat at their center.

First IR camera measurements seem promising but surface thermal emission should be distinguished from bow-tie tip diffraction.

【代表的な原著論文情報】

1) Y Wu, J Ordonez-Miranda, L Jalabert, S Tachikawa, R Anufriev, H Fujita, S Volz, M Nomura, Observation of heat transport mediated by the propagation distance of surface phonon-polaritons over hundreds of micrometers, *Applied Physics Letters* 121 (11), 112203, (2022).

2) J Ordonez-Miranda, YA Kosevich, BJ Lee, M Nomura, S Volz, Plasmon Thermal Conductance and Thermal Conductivity of Metallic Nanofilms, *Physical Review Applied* 19 (4), 044046, (2023).

3) S Volz, M Nomura, J Ordonez-Miranda, Resonant Polariton Thermal Transport Along a Vacuum Gap, *Physical Review Applied* 18 (5), L051003, (2022).