

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

2020 年度 実績報告書
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二次元表面フォノンポラリトンの熱伝導制御

## § 1. 研究成果の概要

In FY 2020, advancements have been achieved in the proof of concept of Surface Phonon-Polaritons (SPhPs) (workpackage 1). Measurements have proven the existence and the long-range (>100microns) propagation of SPhPs in the 300K-400K range by using the  $3\omega$  metrology. Theoretical investigations have also provided better agreement between model and experiments by solving Boltzmann Transport Equation for SPhPs.

In workpackage 2 (guiding and focusing) and in the same range of temperatures, experiments have clearly proven the presence of SPhPs in (SiO<sub>2</sub>/Si/SiO<sub>2</sub>) 2D guides by introducing a gap. The same results also demonstrate super-Planckian radiation in the far-field. Far field measurements in simple Si film with a gap were confirmed by theoretical modeling. Modeling was also developed to predict far-field radiation in the multilayers with or without SPhPs.

In thin SiN films, theoretical works based on Boltzmann Transport Equation for SPhPs also revealed that the coupling between SPhPs and phonons becomes significant when the length of the membrane exceeds the millimeter.

A hot stage (300K-1200K) is now established in the laboratory and operated with  $3\omega$  metrology. An IR camera was also acquired and stage developments are in process to improve the temperature resolution.

## § 2. 研究実施体制

### (1)PI グループ

① 研究代表者:Sebastian VOLZ (CNRS (LIMMS, 東京大学生産技術研究所) ディレクター, シニアリサーチフェロー)

#### ② 研究項目

•1- SPhPs propagation was proven beyond 100 microns in the 300K-400K in thin SiN films (paper in process). Theoretical modeling provided better agreement with experimental data for SiN thin film thermal conductivity.

•2 -SPhPs guiding and tunneling were supported experimentally in (SiO<sub>2</sub>/Si/SiO<sub>2</sub>) multilayer films. The same results also proved super-Planckian radiation in the far-field.

•3- Theoretical modeling revealed SPhPs-Phonons coupling.

### (2)グループ 1

① 主たる共同研究者:野村 政宏 (東京大学生産技術研究所 准教授)

#### ② 研究項目

•1- Proof of concept: new samples were fabricated to highlight the long propagation length of SPhPs by using resistor lines on ultra-thin SiN membranes.

•2- Waveguiding/tunnelling: new set of samples were fabricated to prevent heat leakage between heater and sensor.