

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

2019年度 実績報告書
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Sebastian VOLZ  
(ヴォルツ セバスチャン)

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

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 the year 2019, the proof of concept of Surface Phonon-Polaritons (SPhPs) thermal conductivity (workpackage 1) was provided in SiN films by showing the increase of thermal conductivity with temperature in ultrathin films (30nm and 50nm), while thicker films thermal conductivities are increasing. 3w experiments have also yielded new information on the SiN ultrathin film thermal conductivity but at temperatures below 420K.

Waveguiding of SPhPs (workpackage 2) was shown by analytical calculations in SiO<sub>2</sub>-Si-SiO<sub>2</sub> layered microstructures with larger Phonon-Polariton thermal conductivities than in single SiO<sub>2</sub> layers. Tunneling (workpackage 2) has also been experimentally investigated by measuring the thermal conductance of a gap in a SiO<sub>2</sub>-Si-SiO<sub>2</sub> multilayer with the 3w set-up. This measure allows us to remove the phonon contribution from the heat flux.

## § 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) デイレクター, シニアリサーチフェロー)

#### ② 研究項目

- 1- Boundary scattering was included in the SPhPs thermal conductivity formula to fit the TDTR measurements of SiN thin films.
- 2 - A paper providing the proof of concept of SPhPs thermal conductivity was submitted.
- 3- 3w measurements of the thermal conductivity in SiN thin films was also obtained to confront TDTR measurements.
- 4- The analytical model of SPhPs thermal conductivity in SiO<sub>2</sub>-Si-SiO<sub>2</sub> multilayers proved the waveguiding effect. A paper was submitted on this topic.

### (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 samples : The SiN thin films were instrumented with resistors to implement the 3w measurements.
- 2- Waveguiding/tunnelling samples : Devices including suspended SiO<sub>2</sub>-Si-SiO<sub>2</sub> multilayers were fabricated. A gap was FIB-etched in those multilayers and resistors were deposited to allow for the 3w measurements of the samples.