

マテリアル先端リサーチインフラ利用報告書

ARIM User's Report

[Release : 2024.07.25] [Update : 2024.06.04]

課題データ / Project Data

課題番号 Project Issue Number	23TU0024
利用課題名 Title	Thermoelectric generators
利用した実施機関 Support Institute	東北大学 / Tohoku Univ.
機関外・機関内の利用 External or Internal Use	内部利用 (ARIM事業参画者以外) / Internal Use (by non ARIM members)
横断技術領域 Cross-Technology Area	加工・デバイスプロセス/Nanofabrication
重要技術領域 Important Technology Area	革新的なエネルギー変換を可能とするマテリアル/Materials enabling innovative energy conversion 高度なデバイス機能の発現を可能とするマテリアル/Materials allowing high-level device functions to be performed
キーワード Keywords	Energy harvester, MEMS/NEMSデバイス/ MEMS/NEMS device, 熱電材料/ Thermoelectric material, 熱電発電/ Thermoelectric Power Generation

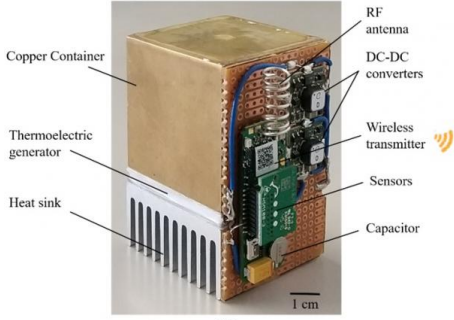
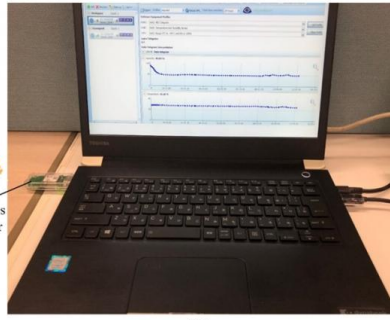
利用者と利用形態 / User and Support Type

利用者名 (課題申請者) User Name (Project Applicant)	Nguyen Toan
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ARIM実施機関支援担当者 Names of Collaborators in The Hub and Spoke Institutes	
利用形態 Support Type	機器利用/Equipment Utilization

利用した主な設備 / Equipment Used in This Project

利用した主な設備 Equipment ID & Name	TU-058 : マスクレスアライナ TU-158 : 芝浦スパッタ装置 (加熱型) TU-159 : 芝浦スパッタ装置 (冷却型) TU-201 : DeepRIE装置#1 TU-216 : Vapor HFエッチング装置
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報告書データ / Report

<p>概要（目的・用途・実施内容） Abstract (Aim, Use Applications and Contents)</p>	<p>This work aims to develop a self-powered wireless IoT sensing system driven by daily ambient temperature energy harvesting.</p>
<p>実験 Experimental</p>	<p>A novel approach using a thermoelectric generator (TEG) which harvests thermal energy from daily ambient temperature fluctuations into electricity as a power source for wireless IoT devices is proposed and investigated. A harvested temperature difference across the TEG is created by employing a phase change material (PCM) which allows the temperature value to be maintained near the melting point at the phase transition during the ambient temperature fluctuations. TEG was made using MEMS technology. Electrodes were deposited by sputtering, photoresist patterned using a maskless aligner, and etched using RIE.</p>
<p>結果と考察 Results and Discussion</p>	<p>Fig. 1. is a fabricated Self-powered wireless IoT sensing transmitter module and the receiver module. Experimental results indicated that the harvested temperature differences are 10°C and 5°C for 300 ml and 30 ml of PCM, respectively, during the ambient temperature variations from 5°C to 25°C. By utilizing the ambient temperature fluctuations between day and night times, an average maximum output power of TEG measured for 3 days is 340 μW and DC-DC electronic conversion efficiency is 28.3%. The total storable energy of approximately 1.46 J for a day is estimated. A capacitor as an energy storage unit could be fully charged and its usable energy is calculated at 0.686 J. The current consumption of 2.1 μA for every transmit cycle is estimated. A self-powered wireless IoT sensing system driven by realistic ambient temperature variations able to sense the ambient temperature as well as the ambient humidity and transmit to a computer via RF communication is demonstrated successfully.</p>
<p>図・表・数式 1 Figures, Tables and Equations 1</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>(a)</p> </div> <div style="text-align: center;">  <p>(b)</p> </div> </div> <p>Fig. 1. (a) Fabricated Self-powered wireless IoT sensing transmitter module. (b) Receiver module.</p>
<p>その他・特記事項（参考文献・謝辞等） Remarks(References and Acknowledgements)</p>	<p>・参考文献 <i>Energy reports</i>, 6, 2022-2029, 2020. <i>International journal of energy research</i>, 45, 15557-15568, 2021. <i>Applied Energy</i>, 311, 118679, 2022. <i>Nano energy</i>, 121, 109186, 2024.</p>

成果発表・成果利用 / Publication and Patents

<p>DOI（論文・プロシーディング） DOI (Publication and Proceedings)</p>	
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口頭発表、ポスター発表 および、その他の論文 Oral Presentations etc.	
特許出願件数 Number of Patent Applications	0件
特許登録件数 Number of Registered Patents	0件