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：2025.06.10】　【Update：2025.04.25】

課題データ / Project Data

課題番号 Project Issue Number	24NM5002
利用課題名 Title	Research on the Space-Material Tectonics Project
利用した実施機関 Support Institute	物質・材料研究機構 / NIMS
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)
ARIM半導体基盤PF 関連課題 Related to ARIM-SETI	指定なし / No Designation
横断技術領域 Cross-Technology Area	計測・分析/Advanced Characterization
重要技術領域 Important Technology Area	次世代ナノスケールマテリアル/Next-generation nanoscale materials 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
キーワード Keywords	表面プラズモン共鳴装置, 三次元電子顕微鏡, ハイエントロピー合金, 光学材料・素子, 環境試験機, プラスチック類,電子顕微鏡/ Electronic microscope,赤外・可視・紫外分光/ Infrared/visible/ultraviolet spectroscopy,X線回折/ X-ray diffraction,電子分光/ Electron spectroscopy,ナノ粒子/ Nanoparticles,ナノ多孔体/ Nanoporuous material,ナノシート/ Nanosheet,メソポーラス材料/ Mesoporous material,燃料電池/ Fuel cell,電極材料/ Electrode material,エネルギー貯蔵/ Energy storage,環境発電/ Energy Harvesting

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)	ヘンジー ジョール
所属名 Affiliation	物質・材料研究機構
共同利用者氏名 Names of Collaborators Excluding Supporters in the Hub and Spoke Institutes	
ARIM実施機関支援担当者 Names of Supporters in the Hub and Spoke Institutes	Yusuke Yamauchi
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	NM-202：硬X線光電子分光分析装置（HAX-PES/XPS） NM-219：フーリエ変換赤外分光光度計（IRAffinity-1S） NM-641：スパッタ装置 [CFS-4EP-LL #2] NM-503：200kV電界放出形透過電子顕微鏡（JEM-2100F1） NM-504：200kV電界放出形透過電子顕微鏡（JEM-2100F2）

報告書データ / Report

概要（目的・用途・実施内容） Abstract (Aim, Use Applications and Contents)	In one major result, we explored the tailored design of mesoporous nanospheres composed of high entropy alloy (HEA) materials for enhanced electrocatalysis. HEA nanospheres (PtPdRuMoNi) exhibit superior catalytic performance for hydrogen evolution (HER) and oxidation (HOR) reactions in alkaline media. In another major result, we developed a microplastic sensor using hierarchical silver (Ag) foams for SERS-based sensing. The Ag foam substrate, combined with neural network-driven spectral analysis, enables pretreatment-free SERS detection of microplastics. The research advances material design strategies for electrocatalysis and environmental sensing, with energy conversion and pollution monitoring applications.
実験 Experimental	The mesoporous HEA electrocatalysts were characterized using HAX-PES (NM202) and TEM (NM503/4) to characterize. Microplastics were characterized using various instruments, and sensing was performed on a confocal Raman microscope.
結果と考察 Results and Discussion	HEA nanospheres showed enhanced electrocatalytic (HER/HOR) activity due to favorable electronic structure and high surface area. Ag foams facilitated pretreatment-free SERS detection of microplastics via via high surface area and strong electromagnetic fields. Microplastic identification was enhanced using machine learning.
図・表・数式 Figures, Tables and Equations	
その他・特記事項（参考文献・謝辞等） Remarks(References and Acknowledgements)	References: 1. "Tailored Design of Mesoporous Nanospheres with High Entropic Alloy Sites for Efficient Redox Electrocatalysis"; Advanced Science, 11, 2402518 (2024) 2. "Pretreatment-free SERS sensing of microplastics using a self-attention-based neural network on hierarchically porous Ag foams"; Nature Communications, 15, 4351 (2024) DOI(Piblication and Proceedings): 1. 10.1002/advs.202402518 2. 10.1021/acsnano.3c11547 3. 10.1038/s41467-024-48148-w 4. 10.1016/j.jmat.2023.08.009 5. 10.1016/j.apsusc.2024.159821

成果発表・成果利用 / Publication and Patents

DOI（論文・プロシーディング）[1] DOI (Publication and Proceedings)	Yijia Luo, Mesoporous gold decorated MXene ($Ti_3C_2T_x$) flexible composite films for photo-enhanced solid-state micro-supercapacitors, *Journal of Materials Chemistry A*, **13**, 1330-1342(2025). DOI: 10.1039/D4TA06043A

DOI（論文・プロシーディング）[2] DOI (Publication and Proceedings)	Mindaugas Juodenas, Lasing in an assembled array of silver nanocubes, *Nanoscale Horizons*, **10**, 142-149(2025). DOI: 10.1039/D4NH00263F
DOI（論文・プロシーディング）[3] DOI (Publication and Proceedings)	Dong Jiang, Substrate Curvature-Induced Regulation of Charge Distribution of Covalent Organic Frameworks Promotes Capacitive Deionization, *Advanced Functional Materials*, **34**, (2024). DOI: 10.1002/adfm.202407479
口頭発表、ポスター発表および、その他の論文[1] Oral Presentations etc.	Entropy stabilized multi-metallic mesopoous nanospheres (Materials Oceania 2024) September 2024.
口頭発表、ポスター発表および、その他の論文[2] Oral Presentations etc.	Enabling more deterministic SERS sensing of environmental contaminants using hierarchical porous metals (Materials Oceania 2024) September 2024.
特許出願件数 Number of Patent Applications	0件
特許登録件数 Number of Registered Patents	0件