

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 : 2024.06.27]

課題データ / Project Data

課題番号 Project Issue Number	23WS0031
利用課題名 Title	シリコン・化合物微細加工光機能デバイス
利用した実施機関 Support Institute	早稲田大学 / Waseda 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)
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 加工・デバイスプロセス/Nanofabrication
重要技術領域 Important Technology Area	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	電子顕微鏡/ Electronic microscope,CVD,光学顕微鏡/ Optical microscope,リソグラフィ/ Lithography,電子線リソグラフィ/ EB lithography,ダイシング/ Dicing

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)	HEINSALU SIIM
所属名 Affiliation	早稲田大学 基幹理工学部 電子物理システム学科
共同利用者氏名 Names of Collaborators Excluding Supporters in the Hub and Spoke Institutes	Takashi Kan; KDDI Research, inc.
ARIM実施機関支援担当者 Names of Supporters in the Hub and Spoke Institutes	Masatoshi Suzuki; KDDI Research, inc.,Hideaki Tanaka; KDDI Research, inc.
利用形態 Support Type	機器利用/Equipment Utilization,技術相談/Technical Consultation

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

利用した主な設備 Equipment ID & Name	WS-015 : 電子ビーム描画装置 WS-016 : レーザー直接描画装置 WS-003 : 電子ビーム蒸着装置 WS-027 : ダイシングソー WS-007 : ICP-RIE装置
---------------------------------	---

報告書データ / Report

概要 (目的・用途・実施内容) Abstract (Aim, Use Applications and Contents)	In recent years, AI has rapidly advanced with novel algorithms and increased computing power, transforming various domains and becoming indispensable in many fields. Despite conventional AI's challenges with long learning times and high power consumption, reservoir computing (RC) has emerged as a promising alternative. This study focuses on feedforward optical RC utilizing multimode waveguides (MMWs). This structure was later utilized in relation to the following project: シリコンフォトニクス光リザバーコンピューティング
実験 Experimental	The samples underwent fabrication on silicon-on-insulator (SOI) substrates through a series of processes, namely electron beam lithography (EBL), inductively coupled plasma reactive ion etching (ICP-RIE), plasma chemical vapor deposition (Plasma-CVD), ultraviolet lithography (UVL), electron beam vapor deposition (EBVD), and wafer dicing. For detailed steps contact: siim.heinsalu@fuji.waseda.jp
結果と考察 Results and Discussion	Simulations demonstrated results such as 0.046 NMSE in Santa Fe prediction and high-performance chaotic time series prediction at 12.5 GS/s on millimeter-scale chips. While the current method generates MMW modes by scanning with a tip-sphere fiber, practical implementation requires considering the placement of an equivalent number of photodiodes (PDs) within the reservoir. Existing reports on Arrayed Waveguide Gratings (AWGs) offer insights into PD placement for single-mode waveguides, but for MMWs in RC, optimal output configurations are unexplored. Further, from experimental analysis mode mixing and all of the ports working as needed was confirmed.
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)	The authors express their gratitude to Advanced Research Infrastructure for Materials and Nanotechnology in Japan (ARIM) of MEXT for granting permission to utilize the cleanroom facilities and equipment essential for fabricating the samples within the scope of this study. Hirotaka Oshima led the primary analysis through simulations for this work, while Siim Heinsalu supervised the experimental aspects. Members from KDDI Research, Inc. played a valuable role in discussions and the design of the device under consideration.

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)	Hirotaka Oshima, Low Loss Fan-Out Structure for Multimode Waveguide-Based Reservoir Computing, <i>2023 International Conference on Photonics in Switching and Computing (PSC)</i> , , 1-3(2023). DOI: 10.1109/PSC57974.2023.10297276
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
--	----