H2020-FETOPEN-2019-01

FET-Open Challenging Current Thinking

POSEIDON

NanoPhOtonic devices applying Self-assembled colloIDs for novel ON-chip light

Starting date of the project: 01/01/2020

Duration: 48 months

= Deliverable D6.7 =

New material integration workshop

Due date of deliverable: 31/01/2023

Actual submission date: 27/01/2023

WP and Lead Beneficiary: WP6, AMO

Version: V1.0

Dissemination level		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 861950.

AUTHOR

Author	Organization	Contact (e-mail, phone)
Stephan Suckow	AMO	suckow@amo.de
Rijil Thomas	AMO	thomas@amo.de
Jana Mwangi	Amires	mwangij@amires.eu

DOCUMENT DATA

Keywords	Dissemination, workshop
Point of Contact	Name: Stephan Suckow Partner: AMO GmbH Address: Otto-Blumenthal-Str. 25 52074 Aachen, Germany Phone: +49 241 8867 127 E-mail: suckow@amo.de

REVIEW PROCESS

Document version	Date	Status/Change
0.1	26/01/2023	Draft
0.2	27/01/2023	Reviewed
FINAL 1.0	27/01/2023	

VALIDATION PROCESS

Reviewers		Validation date
Work Package Leader	Stephan Suckow	26/01/2023
Project Manager	Jana Mwangi	27/01/2023
Project Coordinator	Stephan Suckow	27/01/2023

Executive Summary

This deliverable reports on the workshop on the “Integration of novel materials into silicon photonics”, hosted by AMO on the 21st/22nd November 2022 in Aachen.

Table of contents

1. Workshop idea

The formal announcement of the workshop on AMO's homepage [1] serves as a good overview of the idea of the event:

> "AMO GmbH and RWTH Aachen University are organizing a workshop on November 21-22, 2022 in Aachen, bringing together experts from academia and industry to discuss recent advances on the integration of novel materials into silicon photonic platforms.
>
> In the past decade, the field of silicon photonics has grown tremendously, exploiting standard materials and processes of the semiconductor industry for realizing complex photonic integrated circuits with high yield and high volume. In some cases, however, this approach does not suffice. The integration of novel materials is increasingly seen as a promising route to enhance the functionality of standard silicon and silicon-nitride photonic platforms, and to overcome their limitations – in particular concerning light emission, ultrafast modulation, and nonlinear applications.
>
> The scope of our workshop "Integration of novel materials into silicon photonics" is to present the recent advances of the field, and to discuss the possible advantages and challenges posed by different materials – from quantum dots, to perovskites, to 2D-materials, etc. – and by different integration strategies.
>
> The workshop includes a hybrid session dedicated to the integration of 2D materials [2], in cooperation with the 2D-Experimental Pilot Line."

This information has been posted on LinkedIn [3] as well and was shared broadly there and in the partner networks. The LinkedIn announcement was shared 11 times, triggered 137 reactions overall and made 3098 impressions. The latter is the number the original post was shown in other people's feeds, not counting the impressions of the shared posts. Furthermore, the workshop was promoted on the POSEIDON LinkedIn page.

Figure 1: Promotional image on POSEIDON LinkedIn

The idea to shape the workshop for POSEIDON like this was the following: the light emitter concepts we are researching in POSEIDON can be disruptive to integrated photonics (in a positive way), yet they are still at low technological readiness levels (TRLs) and they are not isolated from the more conventional approaches. It is therefore very beneficial to get a better overview of the state of art, to more clearly identify competing technologies as well as synergy potential.

As the workshop name says directly, the common topic among the different contributions was adding new materials to the established silicon and silicon nitride nanophotonic platforms. The POSEIDON light sources do not consist of one single material, but their means of integration are to some extent comparable to what is needed to integrate e.g. perovskite light emitters. Overall, there was significant overlap with the POSEIDON research in terms of integration technology and light emitter design.

There were 125 registrations (excluding some support staff) and the 2D EPL stream reached more than 200 other people online. The list of attendees is not included in this public document but is available to the project officer and reviewers upon request. There were 26 registrations from AMO, 34 participants from RWTH Aachen University and the remaining half of the participants were from various external institutions. The participants originated from 14 companies, 9 research centers and 27 universities, a mix which proved to be a fruitful basis of discussions between academia and industry.

Figure 2: promotional image for the workshop

2. Workshop program

Monday, November 21, 2022	
11:00 – 12:00	Registration
12:00 – 13:00	Lunch
13:00 – 13:30	Stephan Suckow (AMO GmbH) Opening
13:30 – 14:00	Anna Lena Schall-Giesecke (Fraunhofer IMS, University of Duisburg-Essen) "Material integration into dielectric photonic waveguide platforms"
14:00 – 14:30	Jeremy Witzens (RWTH Aachen University) "Remanent reconfiguration of chalcogenide devices on SOI-photonics"
14:30 – 15:00	Ioannis Zeimpekis (University of Southampton) "Chalcogenides for integrated Photonics"
15:00 – 16:00	Coffee break + Poster session
16:00 – 16:30	Martin Heck (TU/e) "Heterogeneous integration of InP and silicon photonics"
16:30 – 17:00	Fabrice Ranieri (C2N, Université Côte d'Azur) "III-V on Si nanosources"
17:00 – 17:30	Matthias Wuttig (RWTH Aachen University) "Tailoring Phase Change Materials for Photonic and Neuromorphic Applications"
19:00 – 22:00	Workshop Dinner at "Ratskeller" (Markt 40, 52062 Aachen)

Tuesday, November 22, 2022	
09:00 – 09:30	Steven Koester (University of Minnesota) "2D materials integration for integrated optoelectronic applications"
09:30 – 10:00	Loyd J. McKnight (Fraunhofer Centre for Applied Photonics - Glasgow) "Integration of lithium niobate on silicon nitride photonics"
10:00 – 10:30	Ueli Koch (ETH Zürich) "Integration of Plasmonics – Exploiting Nonlinear Materials at Highest Speeds"
10:30 – 11:00	Coffee Break
11:00 – 11:30	Mario Zapata (CSIC) "Nanoantenna-emitter hybrids coupled to waveguides"
11:30 – 12:00	Eva Desgué (THALES) "Growth of $PtSe_2$ films by molecular beam epitaxy for high frequency optoelectronics"
12:00 – 12:30	Delphine Pommier (THALES) "Graphene and $PtSe_2$ based photodetection and optoelectronic mixing"
12:30 – 14:00	Lunch
14:00 – 14:20	Despoina Petousi (ADVA Optical Networking) "An industrial perspective on integrated photonics for telecommunication"
14:20 – 14:45	Round table discussion
14:45 – 15:00	Break
2D-EPL Workshop – Pioneering 2D materials for the semiconductor industry	
15:00 – 15:15	Inge Asselberghs (IMEC) 2D Experimental Pilot Line update
15:15 – 16:00	Dries Van Thourhout (IMEC, Ghent University) "Integration of graphene and 2D-materials on Si and SiN Photonic ICs"
16:00 – 16.30	Mindaugas Lukosius (IHP) "Towards the integration of graphene modulators in a CMOS pilot line"
16:30 – 17:00	Panel discussion

Figure 3: complete workshop program [4]

2.1. Program of 1st day

The first session on Monday started with an overview by Stephan Suckow, focussing on different aspects of new material integration and giving an overview of previous work done at AMO. This was followed by Anna Lena Schall-Giesecke, the former POSEIDON coordinator, who focussed on AMO's work on perovskite light emitters. The next two speakers, Jeremy Witzens and Ioannis Zeimpekis, introduced their work on chalcogenide phase change material integration, which can be used to build tunable and reconfigurable photonic integrated circuits (PICs). Prof. Witzens covered several devices designs, whereas Dr. Zeimpekis focussed more on the fabrication aspects.

After a coffee break including a poster session the 2nd and last session of the day started with a focus on III-V integration, which can be used to create light emitters, phase modulators and detectors on a single substrate. Martijn Heck covered InP whereas Fabrice Raineri discussed InGaAs devices and fabrication technology. The final session of the day switched back to phase change materials. Matthias Wuttig reported in a very lively and interesting way on his research on engineering phase change materials, leading to the discovery of a new class of phase change materials and predictions on the properties of new phase change materials.

2.2. Program of 2nd day

The discussions continued in an informal way at the dinner, before switching to 2D materials for integrated opto-electronics in the first talk of the 2nd day. Steven Koester reported on pioneering work, mainly on graphene integration and devices. This was followed by Loyd McKnight showing their application of the versatile transfer printing method for lithium niobate integration – a technique that can be applied to transfer other thin films as well. In the last talk of the 1st session, Ueli Koch covered plasmonic integration, with a focus on nonlinear optical modulators driven to record high speeds with the help of plasmonics.

In the 2nd session, Mario Zapata gave a talk on the plasmonically enhanced particle-on-a-mirror light emitters we are researching in POSEIDON. Originally, another contribution from the consortium, from the group of Jeremy Baumberg, was planned. However, it had to be canceled due to an injury of the speaker. In the next talk Eva Desgue reported on a new method to grow the 2D material $PtSe_2$ with very high quality whereas in the last talk of that session Delphine Pommier showed the application of graphene and $PtSe_2$ for opto-electronic applications.

The workshop was closed with a session lead by Despoina Petousi on the industrial perspective on integrated photonics (with or without new materials) for telecommunication followed by a round table discussion. In this discussion round the speakers came on stage again and discussed the big picture, including questions from the audience.

2.3. Workshop on 2D Experimental Pilot Line

2D materials have a lot of potential in opto-electronic applications and potential for synergy with other new materials on the silicon photonics platform. AMO had therefore decided to combine the POSEIDON workshop with a workshop on the 2D Experimental Pilot Line (EPL) organized by the 2D EPL team and also streamed online. The 2D EPL is an ambitious project from the Graphene Flagship to push the commercialization of graphene devices by establishing multi project wafer (MPW) runs for graphene devices at several foundries (AMO, IHP, IMEC, VTT). This work focusses on electrical devices but also contains significant work on opto-electronic devices. Combining both workshops allowed the audience to get a state-of-the-art impression on the status, challenges and opportunities of a project as ambitious as integrating a new material onto the established silicon (photonic) platform.

Specifically, in the first talk Inge Asselberghs introduced the project and its current status. This was followed by Dries Van Thourhout giving an overview of what can be done with graphene and other 2D materials on the silicon and silicon nitride photonic platforms. Finally, Mindaugas Lukosius reported on the current status of integrating graphene into the foundry service at IHP, including the MPW run for the 2D EPL. The final program point was a panel discussion with all speakers of the 2D EPL session, moderated by Daniel Neumaier.

2.4. Workshop impressions

After the workshop AMO created a post on LinkedIn [5] with the following images. It achieved 4 shares, 110 reactions (cumulative) and one of the shared posts made 470 impressions (no data for the other ones available).

Figure 4: overview of the workshop meeting room.

Figure 5: POSEIDON coordinator Stephan Suckow with co-organizer Gordon Rinke from AMO, taking care of the 2D EPL session.

Figure 6: opening talk by Stephan Suckow

Figure 4 gives an impression of the venue. Figure 5 shows the two main scientific organizers, who were supported by approximately 10 more people from AMO and RWTH Aachen University. A snapshot of the opening talk is shown in Figure 6, whereas Figure 7 details some posters for the poster session. Overall, there were about 20 posters. Figure 8 is a photograph from the opening of the 2D EPL session, where the Zoom controls for this hybrid session are visible on screen.

POSEIDON was also present at the workshop with a Roll-Up designed by AMIRES and placed next to the stage. Its content is shown in Figure 9.

Finally, AMIRES created a nice summary video, which was posted a few days ago. The LinkedIn post is reference [6], a link to the video is reference [7]. The LinkedIn post has already reached 4 shares, 52 reactions and 419 impressions via one of the shares.

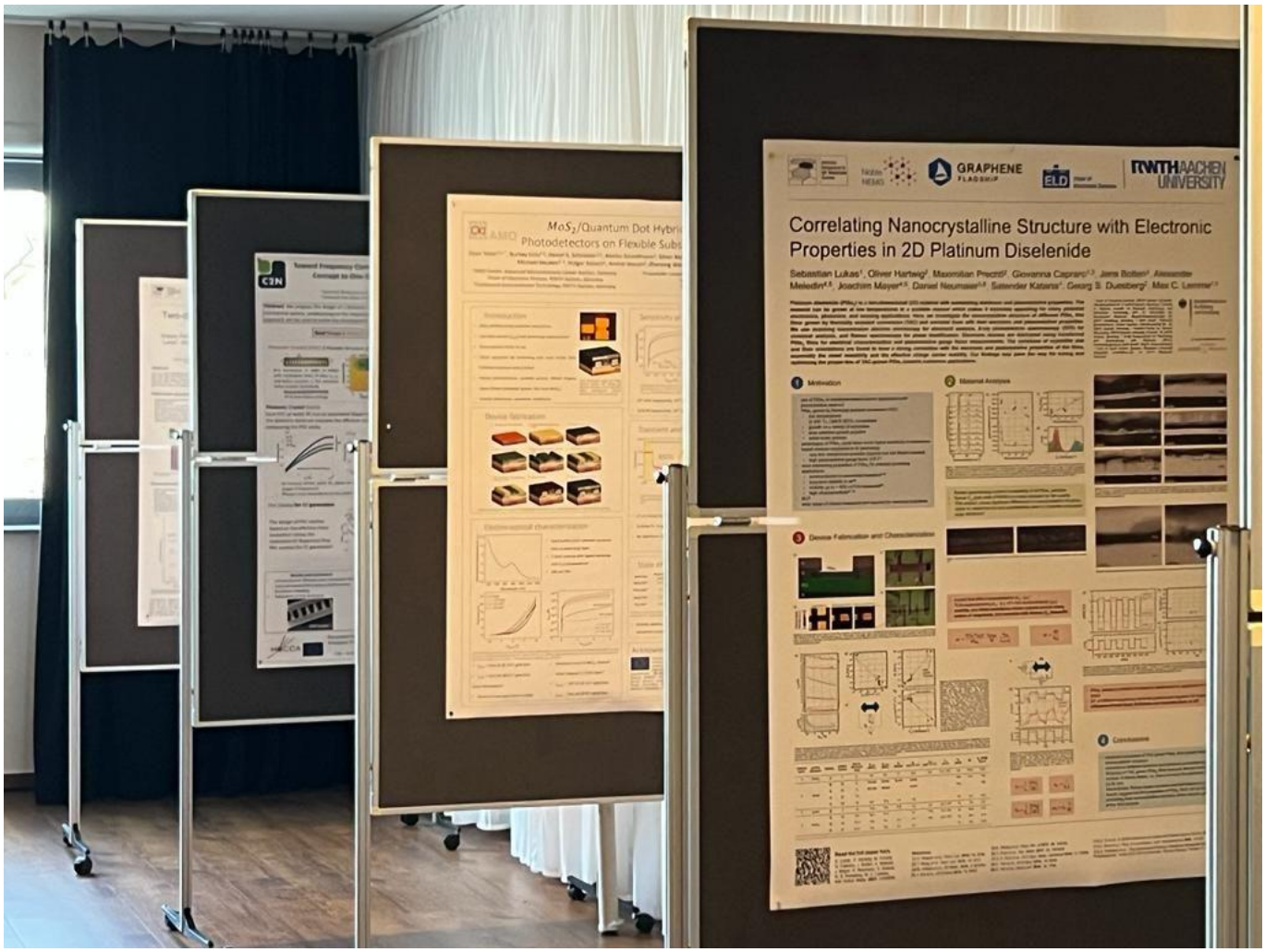

Figure 7: posters for the poster session

Figure 8: introduction of 2D EPL by Inge Asselberghs

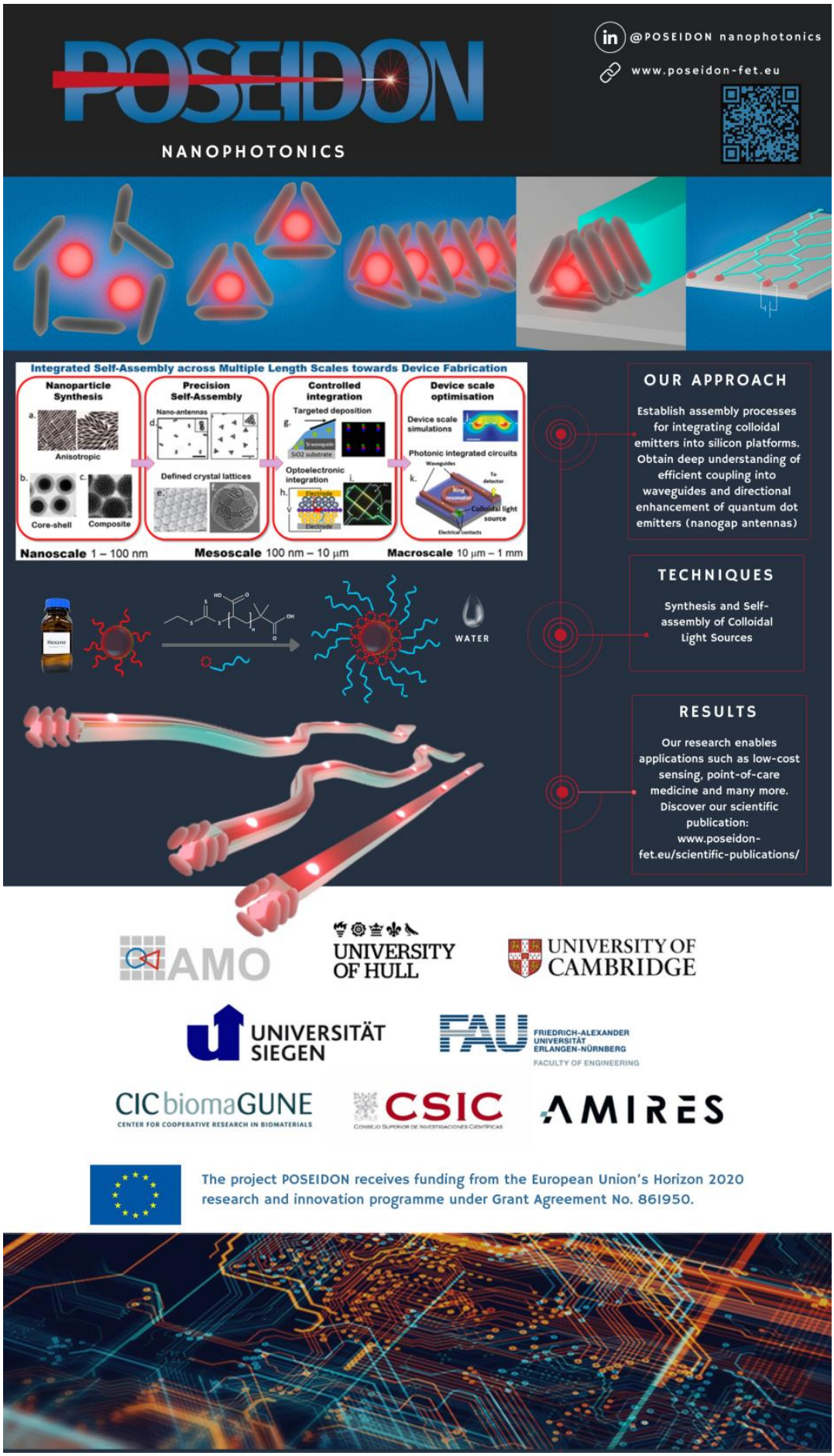

Figure 9: POSEIDON Roll-Up presented at the workshop

3. Conclusions

The workshop was a success, according to internal evaluations of the organizers and feedback received from numerous participants, going so far as asking if there's going to be another one next year. People especially liked the ample time for discussions, as each presentation slot was planned to be 20 minutes of talk plus 10 minutes of discussion. Also the lineup of speakers and the mix of topics were very well received.

Scientific conclusions from the workshop are hard to summarize, given the variety of topics covered and the different priorities that people coming from different fields may have. From the viewpoint of POSEIDON one can single out InP as the technology to beat. The opto-electronic devices like lasers, phase modulators and detectors were already very good at the time of writing the POSEIDON proposal. However, significant progress has been made in the recent years on transfer printing of these materials or entire InP PICs. This technology can be the key development to scale the cost of InP integration down, which previously was the largest issue with this technology.

Nevertheless, fabricating InP light sources is still a very demanding and complex process, which leaves an opportunity for cheaper light sources with less complex fabrication processes, as we are targeting in POSEIDON.

4. Degree of progress

This task is 100% complete.

5. Dissemination level

This Deliverable is public, it will be made available to broad public and published in the project website.

6. References

[1] https://www.amo.de/blog/2022/10/20/workshop-announcement-integration-of-novel-materials-into-silicon-photonics/

[2] https://graphene-flagship.eu/events/pioneering-2d-materials-for-semiconductor-industry-integration-of-2d-materials-into-photonic-platforms/

[3] https://www.linkedin.com/posts/stephan-suckow-34b949199_h2020-mocca-plasmoniac-activity-6990420360403767296-xqJh?utm_source=share&utm_medium=member_desktop

[4] https://www.amo.de/wp-content/uploads/2022/11/WORKSHOP-Program.pdf

[5] https://www.linkedin.com/posts/amo-gmbh_workshop-2depl-activity-7001464606170710016-2uXM/?utm_source=share&utm_medium=member_desktop

[6] https://www.linkedin.com/posts/poseidon-nanophotonics_h2020-mocca-plasmoniac-activity-7021856439220469760-T5q4?utm_source=share&utm_medium=member_desktop

[7] https://poseidon-fet.eu/highlights-from-integration-of-novel-materials-into-silicon-photonics-workshop/