MIcroelectornics RELiability driven by Artificial Intelligence
Project no. 101072491

Deliverable D2.4

Second annual network meeting

WP 2 – Innovative training

Version 1.0

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Revision history

Author(s)	Description	Date
Jacqueline Strehler (accelCH), Peter Fuchs (PCCL)	Draft deliverable	06.08.2024
Qiulin Yu, Vikram Gourishankar Kamble, Fredy John Porathur (PCCL)	Input for the event report	14.08.2024
Peter Fuchs (PCCL)	Revision 1	22.08.2024
Jacqueline Strehler (accelCH)	Revision 2	05.09.2024
Peter Fuchs (PCCL)	Final deliverable	25.09.2024

Executive summary

Background

The deliverable D2.4 is part of work package 2 dedicated to innovative training. It describes the implementation and impact of the second annual network meeting of MIRELAI.

Objectives

The objective of MIRELAI is to provide its doctoral candidates with a comprehensive training programme. The annual network meetings are a key network-wide training activity of MIRELAI and aim to provide structured training along three tracks: scientific, industry and transferable skills.

Outcomes

The second annual network meeting of MIRELAI was hosted by PCCL in Leoben, Austria, from 17 to 20 June 2024. The programme included activities covering all three skills tracks as planned. Over four days, the DCs were provided with scientific lectures, a research project management workshop and two visits to company partners. The DCs were also able to present the progress of their individual research projects and received valuable inputs for their future activities.

Impact

The skills learned in the second meeting will help the DCs in the upcoming activities, especially the next steps in their research projects. The networking further opened up opportunities for additional collaborations between the network partners and strengthened existing bonds.

Next steps

The second annual network meeting is completed, and no further steps will be taken. Feedback from the event's participants will, however, inform the organisation of the third network meeting scheduled for 2025.

Contents

Partner short names

Short name	Partner name
accelCH	accelopment Schweiz AG
ams OSRAM	Ams-Osram AG
AT&S	AT & S Austria Technologie & Systemtechnik Aktiengesellschaft
MCL	Materials Center Leoben Forschungs GmbH
PCCL	Polymer Competence Center Leoben
POLIMI	Politecnico di Milano

Abbreviations

Acronym	Full name
D	Deliverable
DC	Doctoral candidate
FEA	Finite Element Analysis
MCMC	Transitional Markov Chain Monte Carlo
MEMS	Micro-Electromechanical system
GaN SB_MOSFETs	Gallium Nitride Schottky-barrier Metal Oxide Semiconductor Field-Effect Transistors
CMOS-compatible ferroelectric FinFETs	Complementary Metal-Oxide-Semiconductor compatible ferroelectric fin field-effect transistor

1 Introduction

As a key activity of its network-wide training programme, MIRELAI organises annual, in-person meetings. This deliverable, D2.4, covers the second network meeting, hosted by the coordinating institution PCCL in Leoben from 17 to 20 June 2024.

2 Programme

The second network annual network meeting brought together an exciting programme covering many different scientific, industry and transferable skills. The agenda also included two visits to MIRELAI industrial partners: AT&S and ams OSRAM.

Day 1: Research project management training, project information and DC presentations – 17/06/2024

Time	Topic	Responsibility
08:30	*Arrival and coffee*	*All DCs*
09:00	Research project management – Pt 1	Mario Ceccarelli & Jacqueline Strehler (accelCH)
10:45	*Coffee break*	*All participants*
11:00	Research project management – Pt 2	Mario Ceccarelli & Jacqueline Strehler (accelCH)
13:00	*Lunch*	*All participants*
14:00	MIRELAI status update	Peter Fuchs (PCCL)
14:30	DC presentations (10 minutes for each DC = 6x10')	DCs 1,6,10,11,12,13
15:30	*Coffee break + group picture*	*All participants*
16:00	Supervisory and Executive Board Meeting	All + 2 DC representatives
17:00	*End of meeting – Day 1*	

Day 2: DC presentations, scientific lectures + AT&S tour – 18/06/2024

Time	Topic	Responsibility
08:45	*Arrival & coffee*	*All participants*
09:00	DC presentations (10 minutes for each DC = 7x10')	DCs 2,3,4,5,7,8,9
10:15	*Coffee break*	*All participants*
10:45	Uncertainty quantification at the microscale and MEMS reliability	Stefano Mariani (POLIMI)
12:00	*Lunch break*	*All participants*
13:00	Physics of degradation for polymers	Gernot Oreski (PCCL)
14:15	AT&S tour + Introduction	Julia Zündl (AT&S)
17:00	*End of day 2*	
18:00	*Gösser Brewery Tour + dinner*	*All participants*

Day 3: Scientific lectures + ams OSRAM tour – 19/06/2024

Time	Topic	Responsibility
08:45	*Arrival & coffee*	*All participants*
09:00	Modelling of polymers in microelectronics	Peter Fuchs (PCCL)
10:00	*Coffee break*	*All participants*
10:30	Non-organic materials in microelectronics	Elke Kraker (MCL)
11:30	*Lunch break*	*All participants*
12:30	*Transfer to ams OSRAM*	*All participants*
13:30	ams OSRAM tour + Introduction	Fabian Huber (ams OSRAM)
17:30	*Transfer back to Leoben and end of day 3*	

Day 4: Social activity – 20/06/2024

Time	Topic	Responsibility
10:00	*Social activity: Potschnass tour – paddling on the Mur*	*All DCs*
14:00	*End of day 4*	

3 Report

The second annual network week was a success. The meeting was attended by 12 doctoral candidates (DCs) and sixteen supervisors and representatives of the associated partners.

3.1 Day 1

On the first day of the event, Jacqueline Strehler and Mario Ceccarelli of accelCH provided a workshop on research project management to the DCs (See **Figure 1**). The DCs were introduced to the principles of project management. They learned about planning and monitoring a project, the importance of appropriate risk management, reporting and good communication. The workshop included hands-on exercises and the sharing of experiences. Some of the supervisors also participated in the workshop and were able to share their experiences and challenges they faced in research project management, which provided additional depth to the workshop.

Figure 1*. DCs' hands-on exercises during the project management training.*

After the workshop, the first half of the DCs (1, 6, 10, 11, 12, 13), presented the progress of their individual research projects. While the DCs found it challenging to present their project and progress within the

assigned 10-minute time slots, it was a great exercise. The DCs received valuable feedback for the next steps of their research.

The first day also included a meeting of the Supervisory and Executive Boards. In the meeting, the participants were updated about the project's overall progress, including the non-scientific work packages and upcoming activities. All attendees agreed that the project was running well overall.

***Figure 2**. Group picture at the second annual network meeting in Leoben, Austria.*

3.2 Day 2

The second day of the network meeting was opened with the remaining DC presentations (DCs 2, 3, 4, 5, 7, 8, 9). The DCs' topics exhibited the application of artificial intelligence, a key focus of MIRELAI, in difference to the first-day topics which were focussed more on FEA simulations. The DCs' presentations were followed by valuable discussions.

Following this, Stefano Mariani (POLIMI) gave a lecture on "uncertainty quantification at the microscale and (micro-electromechanical system) MEMS reliability". Key methodologies highlighted included on-chip testing and Bayesian inverse modelling, supported by Chapman-Kolmogorov equations and Clenshaw-Curtis quadrature for integration. Additionally, the talk explored the use of Halton sequences, Transitional Markov Chain Monte Carlo (MCMC), and POD-Kriging for efficient sampling and prediction, alongside the application of DenseNet-121 in refining predictive models.

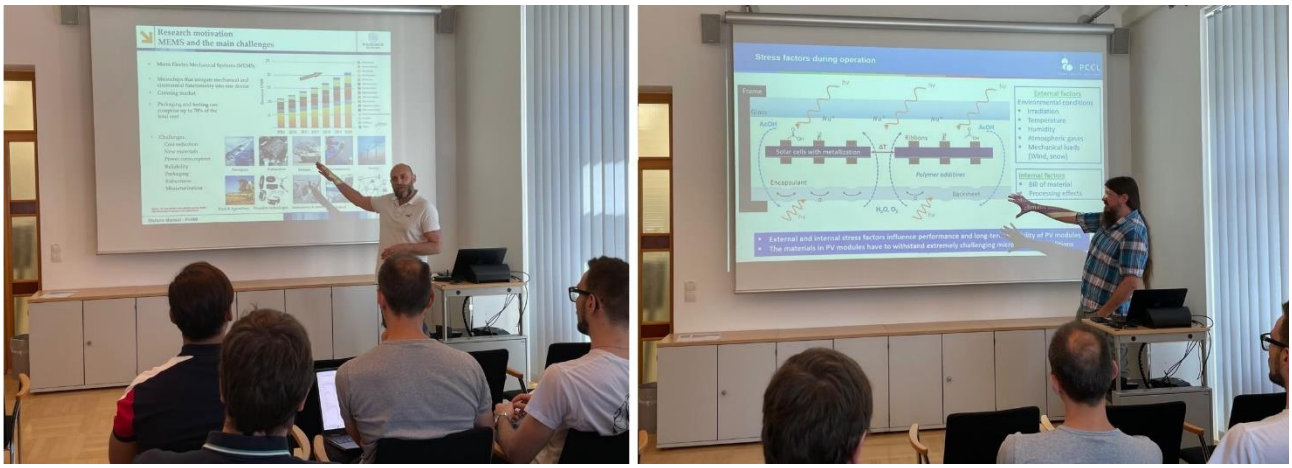

***Figure 3**. Prof. Stefano Mariani (POLIMI) and Dr Gernot Oreski giving lectures on the second day of the meeting*

Gernot Oreski (PCCL) gave a second lecture, which was dedicated to the physics of degradation for polymers. His presentation illuminated how environmental factors and intrinsic material properties collectively influence the ageing behaviour of polymers. He described degradation as a multifaceted process driven by external elements such as UV radiation, thermal stress, oxygen, and moisture, which contribute to the breakdown of polymer chains. The talk detailed how these processes lead to diminished mechanical properties, including reduced tensile strength and elasticity, and can cause issues like discolouration, cracking, and embrittlement over time. Oreski emphasised the critical need to understand these degradation mechanisms to accurately predict the lifespan of polymers, particularly in applications demanding long-term durability, such as in outdoor or high-temperature environments. He also highlighted the importance of advanced testing and modelling techniques to predict and mitigate polymer degradation effectively.

After the lectures, the participants were kindly invited to visit AT&S. Led by Julia Zündel (AT&S), the visit began with an insightful presentation on the company's operations and innovations. This was followed by a video presentation that showcased the virtual PCB space exploration, providing a futuristic glimpse into the design and manufacturing processes. Mrs. Anke Steinberger then led a detailed tour of the fabrication facility, where participants observed the intricate process of PCB production, including the layering of copper, prepregs, and the application of photoresist. The group witnessed various stages such as etching, pressing, mechanical and laser drilling, and the formation of vias. The visit concluded with a demonstration of the reliability testing chambers and the testing methods employed to ensure the durability and performance of the PCBs. Overall, the visit provided a comprehensive understanding of the advanced technologies and meticulous processes involved in PCB manufacturing at AT&S.

The second day was closed out by an exciting tour of the Gösser Brewery. The participants learned about the art of brewing beer and tasted some of the brewery’s products before enjoying a well-deserved dinner.

***Figure 3**. From Gösser Brewery.*

3.3 Day 3

The start of the third day was dedicated to two more scientific lectures. The MIRELAI project’s coordinator, Peter Fuchs, PCCL, gave a talk about the modelling of polymers in microelectronics. The presentation focused on advanced polymer modelling techniques in microelectronics, emphasising the complexities of material behaviour under various conditions. Key topics included linear elasticity, nonlinear deformation, and interface modelling, with a deep dive into the anisotropic, orthotropic, and transversely isotropic material constants. The talk also covered micromechanics approaches like the rule of mixtures, Halpin-Tsai, and shear lag models, as well as the temperature and humidity dependencies of polymer properties. Experimental characterisation and simulation tools like Abaqus were also discussed to accurately predict polymer performance in microelectronic applications.

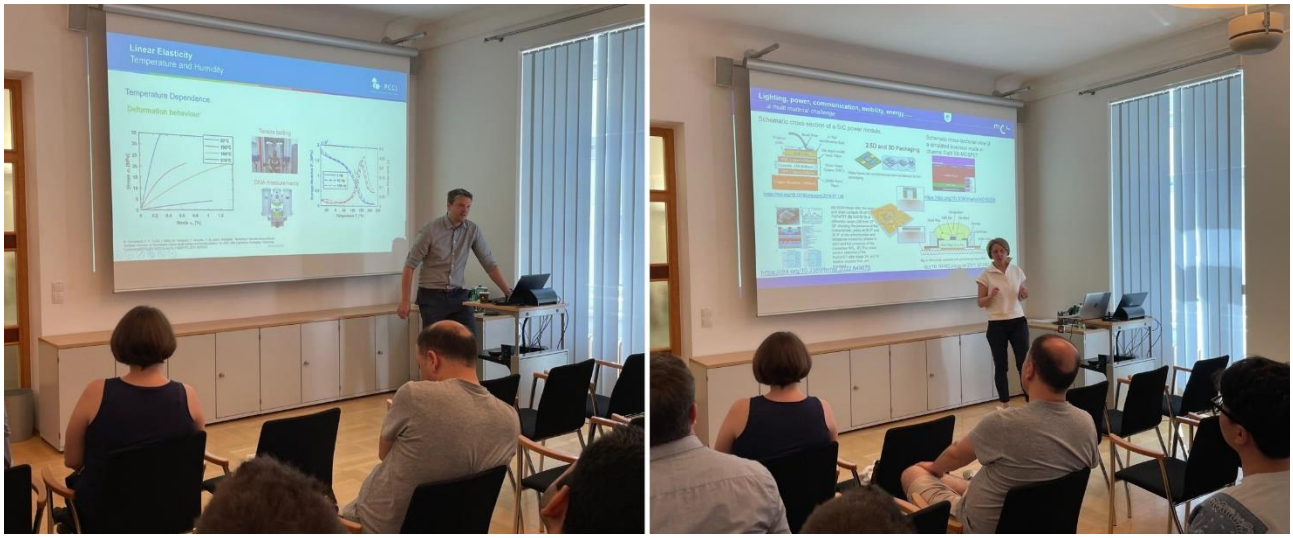

***Figure 4**. Dr. Peter Fuchs and Dr. Elke Kraker(MCL) giving lectures on the third day.*

The second lecture was provided by Elke Kraker (MCL), who talked about non-organic materials in microelectronics. The lecture explored the critical role of non-organic materials in advancing microelectronics, particularly in the realms of lighting, power, communication, and mobility energy. It emphasised the multi-material challenges inherent in 2.5D and 3D packaging technologies and discussed innovations such as SiC power modules, inversion mode n-channel GaN SB_MOSFETs, and CMOS-compatible ferroelectric FinFETs.

The afternoon was filled with the second company visit of the network meeting. The participants were invited to visit the ams OSRAM headquarters in Premstätten near Graz. We had the privilege of visiting the ams OSRAM facility in Graz, and the experience was nothing short of remarkable. As a leader in advanced optical solutions, ams OSRAM seamlessly merges the strengths of both companies, driving innovation at the cutting edge of technology. During our tour, we were particularly impressed by the state-of-the-art technology and the exceptional precision of their manufacturing processes, especially evident in the production of a tiny yet highly sophisticated biomedical device, a colonoscope. We also gained insight into their diverse range of applications, from pioneering automotive lighting to advanced sensor technology, including impressive scanners for airports, which are shaping the future across multiple industries. The expertise and passion demonstrated by the team were truly inspiring, making our visit both enlightening and motivational. Overall, this visit significantly enhanced our understanding of the pivotal role ams OSRAM plays in the global technology landscape.

3.4 Day 4

The final day of the event was limited to the DCs, to provide them with an additional opportunity to socialise and strengthen their team spirit. The group embarked on a paddling adventure along the serene Mur River in Leoben, where participants, ranging from novices to more experienced canoe paddlers, faced both calm and rough waters. Despite some early challenges, such as Marco and Zihan's canoe toppling after hitting a tree, quick action by Kiljan, the instructor, ensured everyone's safety. The team worked together to manoeuvre through the rough sections of the river, transforming the experience into a thrilling and challenging exercise in teamwork. By the end of the day, everyone had gained confidence and skill in paddling, finishing the adventure with a sense of accomplishment and shared memories.

***Figure 4**. Paddling adventure in the Mur.*

4 Impact

The second annual network meeting of MIRELAI provided the DCs with valuable scientific, transferable and industry skills. The DC presentations allowed the DCs to hone their presentation skills, which will be useful for their future in many ways but also provided them with peer feedback and inputs for their research projects. The lessons learned in the scientific lectures will further inform the next steps within their research projects. The DCs earned important transferable skills in the research project management workshop, which will help them to better organise future activities within their individual research projects and beyond. The two company visits broadened the DCs' horizons, covering industry perspectives.

Furthermore, the second network meeting was a key activity to strengthen the network and exchange between the partners. The meeting was a great opportunity for the supervisors and DCs to get to know each other better and explore opportunities for secondments and future collaborations.

5 Next steps

The second annual network meeting is completed, and no further steps will be taken. However, feedback from the participants will inform the organisation of the third annual network meeting in 2025.