CSMB

HUMBOLDT-UNIVERSITÄT ZU BERLIN

Report 2022 – 2025

Dear colleagues, partners, and friends of CSMB,

Materials Science is at the core of addressing some of the world's most pressing challenges:
Sustainable energy, digital transformation, resource efficiency, and health resilience.

The Center for the Science of Materials Berlin (CSMB) was founded with the goal of fostering innovation and excellence at the intersections of disciplines, institutions, and sectors.

Over the past years, the CSMB has evolved into a vibrant hub of interdisciplinary research. We have expanded our collaborations, launched new initiatives in research and education, and opened our doors to the broader public through science communication and outreach. With a growing network of institutional partners, cutting-edge infrastructure, and a dedicated team, we are laying the foundation for a more sustainable and inclusive scientific future.

We are proud of the achievements documented in this report and are grateful to all who contributed.

Prof. Stefan Hecht, Ph.D.
Founding Director of the CSMB

Content

From Vision to Reality:

Founding the CSMB

The establishment of the Center for the Science of Materials Berlin in 2022 marked a milestone in institutionalizing interdisciplinary materials research at HU Berlin. As a central institute, CSMB operates across faculties and bridges academic disciplines with university partners, e.g., the Berlin University Alliance, the non-university partners in the Berlin Research 50 and non-academic partners. It is located in a brand new research building in Adlershof, which provides state-of-the-art infrastructure for synthesis, characterization, and device prototyping within a single integrated space. CSMB's organizational model supports long-term collaboration across disciplines and institutions.

CSMB evolved from IRIS Adlershof, founded in 2009 as a temporary integrative research institute, with the mission to bridge the gaps between physics, chemistry, and mathematical sciences. Over a decade, IRIS became a nucleus for hybrid materials research, gaining national and international visibility. The research building, inaugurated in 2021, laid the foundation for a permanent institutional structure to support hybrid systems research. Based on a strong evaluation by an international advisory board, the central institute CSMB was officially established in 2022. Since then, it has grown into a platform for innovation, attracting talents, and fostering coordinated research across Berlin's academic ecosystem.

What Drives Us Forward:

Mission of the CSMB

Materials research lies at the heart of solutions to global challenges ranging from climate change to digital transformation. Hence, the CSMB is committed to a holistic and integrative understanding of materials research. As an interdisciplinary central institute of Humboldt-Universität zu Berlin, it is closely affiliated with the Faculty of Mathematics and Natural Sciences, while purposefully building bridges to the life sciences, cultural studies, and beyond. The CSMB brings together key principal investigators from HU Berlin and an extended network of collaborators from chemistry, physics, data science, biology, as well as design and cultural sciences. By pooling this expertise, the CSMB pioneers the development of innovative materials, advances their transfer into real-world applications, and educates the next generation of material scientists.

The CSMB aims to generate fundamental knowledge that can be translated into sustainable technologies and impactful innovations. The research at the center combines materials synthesis, advanced characterization, theoreti-calmodeling, and scalable processing techniques. These core activities are complemented by the use of artificial intelligence-based methods such as machine learning, which accelerate discovery and optimization.

In addition to its scientific breadth, the CSMB is uniquely committed to transdisciplinarity. Inspired by natural systems and cultural perspectives, the center

ENERGY CONVERSION & STORAGE

Developing sustainable and resilient materials for efficient and scalable photovoltaic cells, solar fuels, and battery systems

CHARACTERIZATION

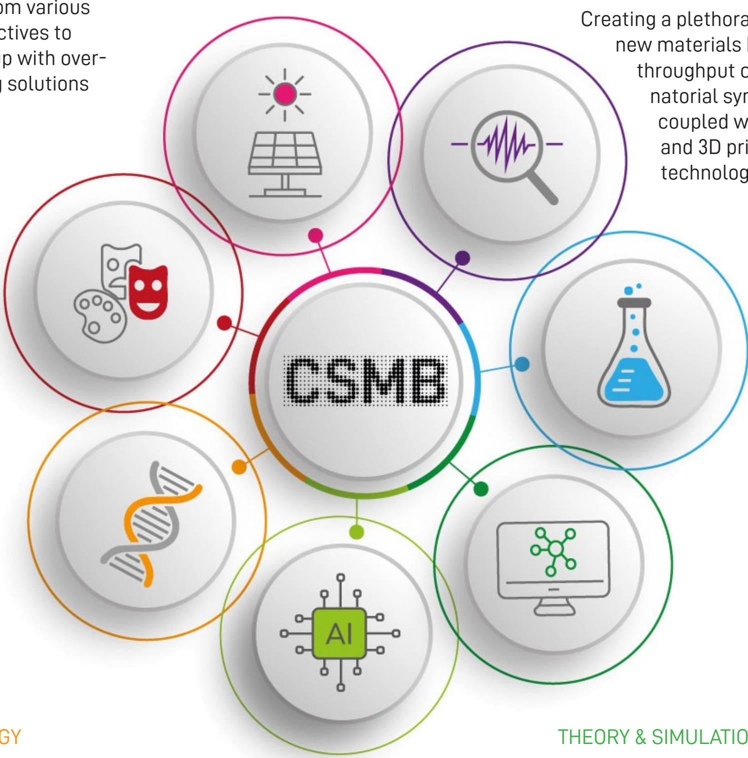
Utilizing state-of-the-art operando techniques to unravel material performance under real life conditions

CULTURE & DESIGN

Looking at materials from various perspectives to come up with overarching solutions

SYNTHESIS & PROCESSING

Creating a plethora of new materials by high throughput combinatorial synthesis coupled with 2D and 3D printing technologies



BIOLOGY

Creating materials with enhanced properties by drawing inspiration from nature

THEORY & SIMULATION

Understanding fundamental structure-property relationships on ultimate scales and predicting yet unknown materials

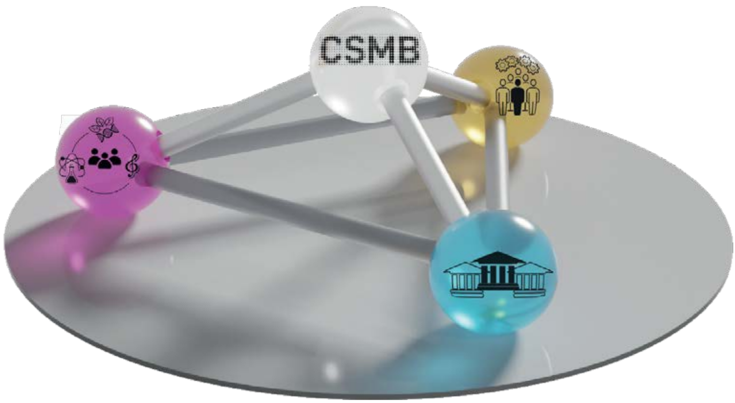
DATA & AI

Managing FAIR research data and exploiting it to accelerate materials discovery and development explores how materials interact not only at the atomic level but also within societal contexts. For example, it investigates how biological mechanisms can inspire the design of smart materials, and how materials shape – and are shaped by – social practices and cultural meanings.

Thematically, the core of CSMB's research is on sustainable (opto-)electronic and catalytic materials, especially for renewable energy applications such as photovoltaics and next-generation batteries. A strong focus is on printed and coated materials that offer scalable, cost-effective routes for device fabrication as well as on FAIR data management and AI-guided materials development, to accelerate the discovery of materials with the desired characteristics through data-driven methods.

This comprehensive approach is embedded in a strong culture of cooperation with university and non-university partner institutions. It is anchored in shared infrastructure, as well as joint labs and strategic projects.
By integrating science, education, and societal engagement, the CSMB embodies the idea of research as a transformative force:

Bridging disciplines, institutions, and cultures to materialize a sustainable and inclusive future.



The Hands and Minds of Science: People

The center's success is driven by a diverse and dedicated community that brings together expertise from across disciplines and professions. Whether in research, administration, technical operations, or science communication, it is the people who shape the spirit and culture, and ultimately, the success of the CSMB.

Principal Investigators

Principal investigators lead research at the scientific frontier. They define the CSMB's academic profile and drive its interdisciplinary mission.
In addition to the ten founding members, Philipp Adelhelm and Eva Unger were admitted in 2023.

Prof. Stefan Hecht, Ph.D.

Director of the CSMB

Professor
Department of Chemistry & CSMB,
Humboldt-Universität zu Berlin

Stefan Hecht studied chemistry at HU Berlin and the University of California, Berkeley, where he also obtained his PhD in Organic Polymer Chemistry under Prof. Jean M. J. Fréchet. He started his independent career at Free University Berlin and subsequently at the MPI for Coal Research in Mülheim/Ruhr before accepting a call to Humboldt University as full professor in 2006. From 2019 until 2022 he was Scientific Director of the DWI – Leibniz Institute for Interactive Materials and held the Chair of Macromolecular Chemistry at RWTH Aachen University before returning to his alma mater as Einstein Professor and Founding Director of the Center for the Science of Materials Berlin. Stefan's achievements have been recognized by multiple awards, prizes, and academic distinctions and he has been inducted in national and European academies.

Stefan's research interests range from synthetic macro/supramolecular chemistry to surface science with particular focus on developing photoswitchable molecules to remote-control materials, devices, and manufacturing as well as physical, chemical, and biological processes.
At CSMB, he fosters interdisciplinary innovation by linking chemical synthesis with applications in electronics, energy conversion, and volumetric 3D printing. His leadership anchors the CSMB's transdisciplinary commitment to design-inspired materials research.

Prof. Dr. Emil J. W. List-Kratochvil

Vice-Director of the CSMB

Professor,
Departments of Physics & Chemistry
& CSMB, Humboldt-Universität zu Berlin

Group Leader,
Helmholtz-Zentrum Berlin für
Materialien und Energie, Berlin

Emil List-Kratochvil studied physics at the Graz University of Technology and Edinburgh Napier University and completed his doctorate also at TU Graz. He later held a faculty position there and became Founding Director of the NanoTecCentre Weiz.
In 2015, he was appointed as Professor for Hybrid Devices at HU Berlin and since 2018, he also leads a research group at the HZB. Since 2025, he acts as the dean of the faculty for natural sciences and mathematics. By directing one of the key Joint Labs on printed hybrid devices, he has helped define Adlershof's materials research profile. He is a frequent keynote speaker at international conferences on organic electronics and device printing.

Emil leads the development of electronic and optoelectronic devices using scalable additive manufacturing, working at the interface of materials science and device physics. His team fabricates transistors, photodetectors, and energy harvesting components on flexible, large-area substrates. To achieve low-cost, high-throughput fabrication suited for industrial use, he applies inkjet printing, spray coating, and roll-to-roll processes.
At CSMB, he drives the translation of fundamental discoveries into practical applications and fosters innovation in nanostructure design, printable semiconductors, and hybrid systems.

Prof. Dr. Philipp Adelhelm

Professor,
Department of Chemistry & CSMB,
Humboldt-Universität zu Berlin

Group Leader,
Helmholtz-Zentrum Berlin für
Materialien und Energie, Berlin

Philipp Adelhelm studied materials science at the University of Stuttgart and completed his PhD in physical chemistry at the Max Planck Institute for Colloids and Interfaces in Potsdam under the supervision of Prof. Markus Antonietti. After postdoctoral research at University of Utrecht and a faculty position at Justus-Liebig Universität Gießen, he was appointed as full professor at Friedrich-Schiller-Universität Jena. In 2019, he came to HU Berlin as full professor and since 2020, he also leads a research group at HZB. He received an ERC Consolidator Grant in 2019 and the Berliner Wissenschaftspreis in 2025.

Phillipp's research focuses on battery materials and electrochemical energy storage. He investigates lithium-ion, sodium-ion, and dual-ion batteries, with a particular interest in solid–electrolyte interfaces, reaction mechanisms, and material degradation. His group combines advanced synthesis with operando techniques like X-ray absorption spectroscopy, diffraction, and electron microscopy to study how materials behave during charging and discharging. By connecting structural changes to performance loss, he develops design rules for longer-lasting, more sustainable battery systems.
At CSMB, he contributes key expertise in interface characterization and energy materials, strengthening the center's focus on sustainable technologies and data-driven materials optimization.

Prof. Dr. Claudia Draxl

Professor,
Department of Physics & CSMB,
Humboldt-Universität zu Berlin

Speaker of FAIRmat
(NFDI for Condensed-Matter Physics
and the Chemical Physics of Solids)

Claudia Draxl received her PhD and habilitation in Physics from the University of Graz, Austria and became a full professor at the Montanuniversität Leoben. She joined HU Berlin in 2011 as professor for Theoretical Solid-State Physics. She led major international research initiatives. Prof. Draxl is the spokesperson of the NFDI consortium FAIRmat, which develops a FAIR data infrastructure for materials data and has contributed to shaping open science policy in Germany and Europe. She is a fellow of the American Physical Society, a member of the Austrian Academy of Sciences, and a member of the German Academy of Science, the Leopoldina.

Claudia's work focuses on electronic-structure theory and *ab initio* modeling of complex materials. She develops and applies cutting-edge computational methods to explore materials' optical, electronic, and excitonic properties, especially in hybrid systems, layered compounds, and interfaces. A pioneer in reproducible research, she promotes FAIR data standards and integrates machine learning into computational materials design. She is a founder of NOMAD, the biggest repository for materials science data.
Her leadership in FAIRmat connects the center's research to national and international infrastructures, enabling data-driven discovery and open, collaborative science.

Prof. Dr. Saskia F. Fischer

Professor,
Department of Physics & CSMB,
Humboldt-Universität zu Berlin

Saskia Fischer studied physics at the Universität Stuttgart and the University of Bristol and conducted her diploma thesis at the Max-Planck Institute of Metal Research where she also conducted her Ph.D. under the supervision of Prof. Dr. Kronmüller. After her Ph.D., she went to the Ruhr-Universität Bochum where she acted as university lecturer. In 2010, she became full professor at HU Berlin. She coordinates the Joint Lab for Advanced Magneto-Transport in partnership with IKZ.

Saskia's work explores the electronic transport properties of low-dimensional materials, particularly under extreme conditions such as high magnetic fields and cryogenic temperatures. Her group investigates quantum Hall effects, interface phenomena, and magneto-transport in complex semiconductors and oxide systems. These insights inform the development of future quantum and neuromorphic devices.
At CSMB, she anchors experimental research on quantum materials and interfaces, providing expertise in precise low-temperature measurement techniques and high-mobility materials. Her interdisciplinary work supports the translation of quantum phenomena into novel device architectures.

Prof. Dr. Christian Kassung

Professor,
Department for Cultural Sciences
& CSMB,
Humboldt-Universität zu Berlin

Christian Kassung studied philosophy, mathematics, and physics in Aachen and Cologne. Christian Kassung has held the Chair of Cultural Techniques and History of Knowledge at Humboldt-Universität zu Berlin since 2006. He is a member of the Hermann von Helmholtz Center for Cultural Techniques. In addition, he is a Principal Investigator in the Cluster of Excellence "Matters of Activity". Christian Kassung has authored widely on media theory, knowledge cultures, and epistemic architectures.

Christian's work investigates how material knowledge is generated, represented, and transformed across disciplines and historical contexts. He examines the role of instruments, practices, and symbols in scientific and cultural production, from early physical apparatus to digital simulation.
At CSMB, he provides critical reflection on the societal dimensions of materials research. His expertise supports the integration of cultural studies into science and technology, helping to articulate responsible innovation, design thinking, and reflective transdisciplinarity at the interface of matter and meaning.

Prof. Dr. Christoph T. Koch

Professor,
Department of Physics & CSMB,
Humboldt-Universität zu Berlin

Christoph T. Koch studied physics at Ruprecht-Karls Universität Heidelberg and Arizona State University, where he also earned his PhD in Solid State Physics under the supervision of Prof. John C. H. Spence. Following a postdoctoral appointment at the Max Planck Institute for Metals Research in Stuttgart, he became Carl-Zeiss Endowed Professor at the University of Ulm, before joining Humboldt-Universität zu Berlin in 2015 as full professor. Prof. Koch is widely known for his expertise in electron microscopy and leads the BeAM mircoscopy center. Furthermore, he is very active in open science and is deputy spokesperson of the NFDI consortium FAIRmat.

Christoph's expertise lies in advanced transmission electron microscopy. His research combines experimental innovation and computational methods to probe the atomic structure and dynamics of complex materials, with a focus on quantum materials, energy materials, catalysts, and nanostructured systems. He develops new reconstruction algorithms and applies deep learning to inverse imaging problems, enabling unprecedented insight into real-space structure and functional properties at the nanoscale.
At CSMB, he leads the BeAM microscopy center, bridging data science, electron optics, and sustainable materials design. His role is central to advancing atomically resolved, in-operando materials characterization.

Prof. Dr. Norbert Koch

Professor,
Department of Physics & CSMB,
Humboldt-Universität zu Berlin

Group Leader,
Helmholtz-Zentrum Berlin für
Materialien und Energie, Berlin

Norbert Koch studied technical physics at the Technical University of Graz and also obtained his doctorate there. After a postdoctoral period at Princeton University, he came to HU Berlin as Emmy-Noether Group Leader in 2003. He was appointed as full professor at HU in 2009. Since 2010, he is also group leader at the HZB. Norbert Koch is internationally recognized for his work at the interface of organic electronics, surface science, and 2D materials, and has already led major research consortia in this area. He holds several academic distinctions and serves on multiple editorial boards in the field of applied physics and materials science.

Norbert investigates hybrid material systems with a focus on interfacial electronic structure and charge transport phenomena. His group uses mostly photoelectron spectroscopy to study molecular and 2D semiconductors, as well as their interfaces with metals and dielectrics. These insights are vital for optimizing energy level alignment, charge injection, and barrier formation in optoelectronic devices.
At CSMB, he bridges the gap between fundamental surface physics and applied materials design. His work contributes to the development of new functionalities in organic–inorganic hybrid systems, relevant for photovoltaics, flexible electronics, and sensor technologies.

Prof. Dr. Matthew Larkum

Professor,
Charité, Department of Biology
& CSMB,
Humboldt-Universität zu Berlin

Matthew Larkum earned his PhD in neuroscience at the University of Bern and held faculty positions at the Max Planck Institute for Medical Research in Heidelberg and the University of Bern. He is now Professor of Neurobiology at HU Berlin and member of the Cluster of Excellence NeuroCure. Prof. Larkum has received major distinctions, including an ERC Grant. He is internationally recognized for uncovering how neurons integrate information across brain regions.

Matthew investigates the cellular basis of cognition, particularly the integrative and computational functions of pyramidal neurons in the cerebral cortex. His research uses electrophysiology, optogenetics, and computational modeling to explore how different brain layers and inputs are combined.
Within the CSMB, he contributes a biological and neuro-inspired perspective on materials and computation, enriching cross-talk between brain science, data-driven materials, and neuromorphic devices. His work exemplifies how concepts from biology can inform next-generation materials systems.

Prof. Dr. Nicola Pinna

Professor,
Department of Chemistry & CSMB,
Humboldt-Universität zu Berlin

Nicola Pinna studied physical chemistry at Université Pierre et Marie Curie where he also conducted his PhD. Afterwards, he went as a postdoctoral researcher to the Fritz Haber Institute of the Max Planck Society and Max Planck Institute of Colloids and Interfaces. He has held additional research positions in South Korea and Portugal. Since 2012, he is full professor at HU Berlin. He is known internationally for his contributions to nanomaterials synthesis and has co-authored over 300 publications. He is a member of the editorial board of Nanoscale and co-editor of several books on nanochemistry.

Nicola's research focuses on the controlled synthesis of functional nanostructures, including oxides, sulfides, and heterostructures. His group is particularly known for pioneering work on non-aqueous sol–gel synthesis, atomic layer deposition, and hybrid nanocomposites. Applications range from electrocatalysis and energy storage to gas sensing and magnetic devices.
Within the CSMB, he contributes to the development of hierarchically structured hybrid materials with precisely engineered properties, relevant to catalysis and sustainable technologies. His work exemplifies bottom-up materials design and nanoscale integration.

Prof. Dr. Eva L. Unger

Head of Department,
Helmholtz-Zentrum Berlin (HZB)

Professor,
Department of Chemistry & CSMB,
Humboldt-Universität zu Berlin

Eva Unger studied chemistry at the Universität Marburg and earned her PhD in Physical Chemistry from Uppsala University, followed by postdoctoral research at Stanford University and the University of Lund. She later established her own research group at Helmholtz-Zentrum Berlin, where she is now the head of a department. In 2022, Eva Unger became appointed as W2-S professor at the HU Berlin. Eva Unger has received numerous distinctions, including the Helmholtz High Impact Award. She plays an active role in several national and international solar energy initiatives.

Eva's work focuses on scalable fabrication of high-performance optoelectronic devices, especially perovskite solar cells. Her group combines solution-based processing, ink formulation, and in-operando diagnostics to optimize materials and interfaces at industrially relevant scales. By investigating film formation mechanisms and degradation pathways, she advances the understanding of device stability under real-world conditions. A strong advocate of open science and sustainable technology, she integrates her research with data-driven methods and FAIR data practices.
Her contributions strongly align with CSMB's mission to connect materials discovery with technological impact—particularly in renewable energy and printable electronics.

Prof. Dr. Jürgen P. Rabe

Professor,
Department of Physics & CSMB
Humboldt-Universität zu Berlin
Senior Member

Jürgen Rabe received his doctorate in physics from the Technical University Munich and held research posts at IBM Research (San José), Max Planck Institute for Polymer Research, and at the Johannes Gutenberg-University Mainz. He joined HU Berlin in 1994 as Full Professor. Jürgen Rabe is member of the Cluster of Excellence "Matters of Activity". Prof. Rabe is a pioneer in scanning probe microscopy and single-molecule manipulation and has received multiple international awards. He has contributed to foundational research in nanoscience and molecular systems and established IRIS Adlershof.

Jürgen explores the structural and functional organization of molecular and polymeric systems at surfaces and interfaces. His work spans from single-molecule studies to ultrathin organic films, with a strong emphasis on molecular recognition, supramolecular assemblies, and functional interfaces. Techniques include atomic force microscopy, STM, and electron microscopy. At CSMB, his expertise supports work on hybrid systems, molecular electronics, and precision interfaces.
His long-standing commitment to interdisciplinarity, bridging physics, chemistry, and cultural sciences, aligns strongly with the CSMB mission.

Scientific Staff

Scientific staff contribute expertise in experimentation, theory, and instrumentation, supporting the development and execution of collaborative projects.

Dr. Patrick Amsalem
Photoelectron Spectroscopy

Dr. Benedikt Haas
Electron Microscopy

Dr. Giovanni Ligorio
Device Fabrication

Dr. Nikolai Severin
Scanning Probe Microscopy

Technical Staff

Technical staff ensure smooth operation of laboratories, facilities, and IT infrastructure, enabling reliable and high-quality research.

Andreas Haselow

IT & Systems Support

Dr. Kristin Klaue

Chemical Laboratories

Bodo Kranz

Research Building Operations

Katrina Coogan

Electron Microscopy

Administrative Staff

Administrative staff engage in day-to-day operations, while also coordinating strategic development, science management, and communications.

Nora Butter
Administrative Managing Director

Dr. Annika Scior
Scientific Managing Director

Dr. Omar Al-Khatib
Technical Director

Martin Bogner
Outreach & Communication

Christian Pugatschow
Executive Assistant

Collin Dey
Student Assistant

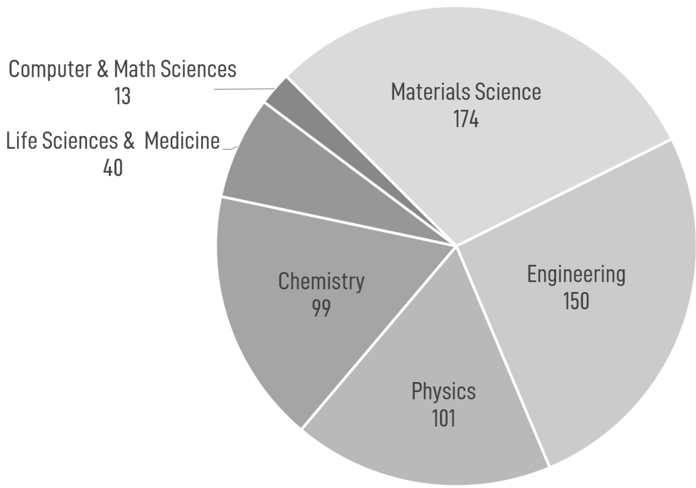
Farewell to Nikolai Puhlmann

When Dr. Nikolai Puhlmann joined Campus Adlershof to work with Prof. Jürgen Rabe in 2009, he started with a small office but big ambitions. With a steady hand and remarkable foresight, he transformed the Integrative Research Institute from a concept on paper into an internationally recognized beacon of science. As its managing director, he paved the way for the CSMB, which he steered through its founding phase from 2022 until 2024, and supported the administration office as senior advisor until his retirement.

We thank Nikolai for his dedication, vision, and collaborative spirit, which have shaped our center and will continue to guide us.

Beacons of Discovery:
Scientific Highlights

In the first three years, CSMB researchers were able to publish 275 peer-reviewed articles and reviews in international scientific journals, including Advanced Materials, Nature Materials, Journal of the American Chemical Society, Angewandte Chemie International Edition, and Nature Communications.
In this section of the report, we aim to highlight a few of them that represent the width of research performed at the CSMB.



Publications by topic (PIs, 10/'22 - 9/'25; Source: scopus.com; non-exclusive counts).

Highlight 1: Mapping Atomic Vibrations - Insights into Heat Transport

In the world of tiny devices and advanced electronics, heat management is key. This study explores how phonons – vibrations that carry heat – behave at grain boundaries in silicon, which are tiny internal interfaces in a material. Using cutting-edge monochromated electron energy loss spectroscopy (EELS) inside a scanning transmission electron microscope (STEM), Christoph Koch, Benedict Haas and their team achieved atomic resolution when measuring how these vibrations change. They found that certain boundaries can act like miniature waveguides for phonons, channeling heat in very specific ways. These findings are confirmed by theoretical simulations, showing a strong match between experiment and theory. Such localized vibrational behaviors could pave the way for novel 'phononic' devices that means technologies that control heat flow using engineered materials.

This breakthrough is particularly relevant for materials science at CSMB, as it links atomic-scale defects with macroscopic material performance. It also highlights the strength of interdisciplinary approaches combining experimental physics, microscopy, and theoretical modeling to understand complex materials systems.

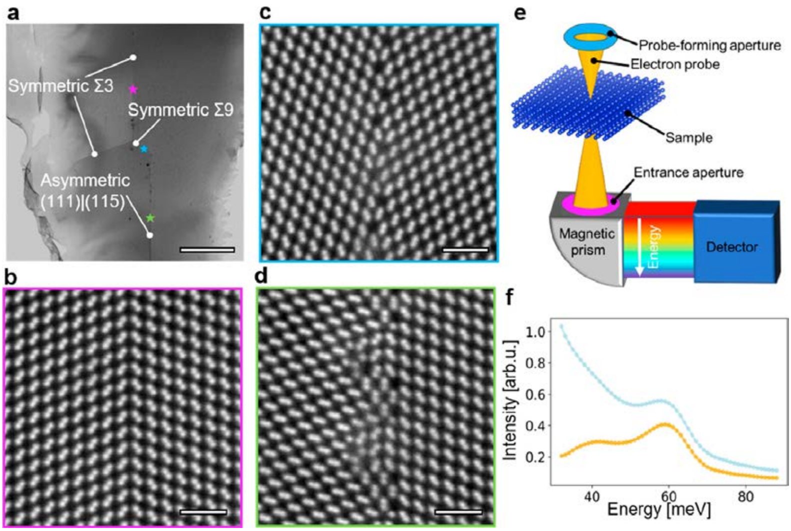
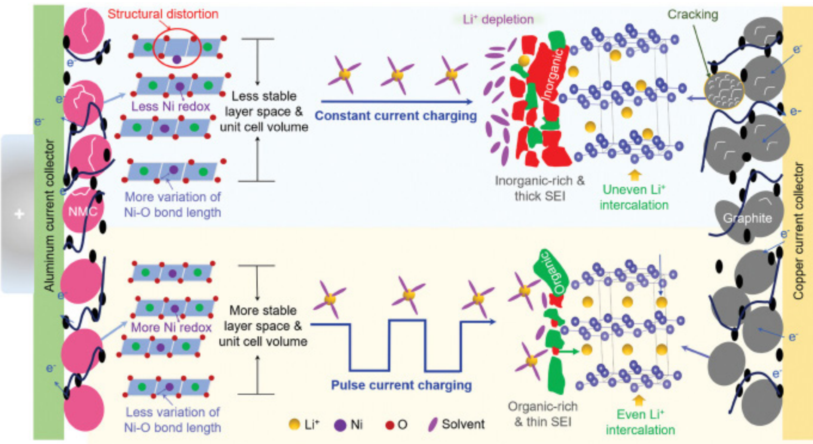


Figure a shows a bright-field STEM image of a silicon sample in [1$\bar{1}$0] orientation with different grain boundaries (Σ3, Σ9, and (111)|(115)). Dark spots are due to carbon contamination. Figures b–d give close-up High-Angle Annular Dark Field images of these boundaries. Figure e illustrates how the EELS measurements were carried out: A focused electron beam hits the sample, scattered electrons are collected, separated by energy, and recorded by a detector. Figure f presents a spectrum from bulk silicon, where subtracting the zero-loss peak reveals phonon signals.

Benedikt Haas, Tara M. Boland, Christian Elsässer, Arunima K. Singh, Katia March, Juri Barthel, Christoph T. Koch, and Peter Rez
Nano Letters (2023), DOI: 10.1021/acs.nanolett.3c01089

Highlight 2: Smarter Charging Makes Batteries Last Longer

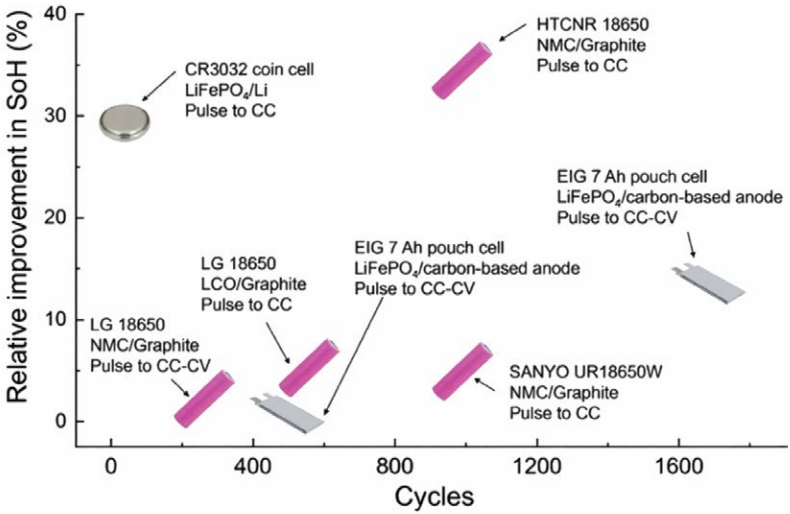
As lithium-ion batteries become central to our energy future, improving their longevity is essential. The authors' analysis of commercial NMC532/graphite batteries shows that a simple change in charging – using pulses rather than a constant current – slows material aging, reduces harmful interfacial layer buildup, and mitigates structural damage in electrodes, effectively doubling their service life.



Mechanisms of pulse current charging for stabilizing the cycling performance of commercial NMC/graphite LIBs.

Using a combination of electrochemical tests, X-ray methods, Raman spectroscopy, and electron microscopy, the team of Philipp Adelhelm uncovered the physical and chemical reasons behind this improvement. These insights pave the way for smarter battery management protocols and have direct implications for energy storage, transportation, and sustainability.

This research connects directly to the CSMB's interest in functional energy materials and interfaces, showing how materials understanding can lead to practical innovation.

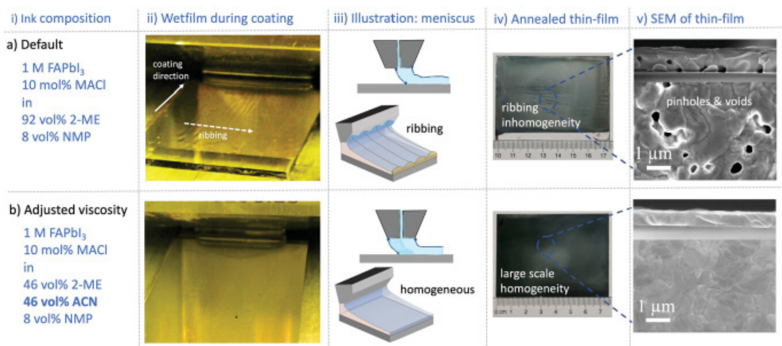


Relative improvement in SoH (State of Health) of Li-based batteries under pulse current charging compared to continuous current charging protocols (CC: constant current; CV: constant voltage).

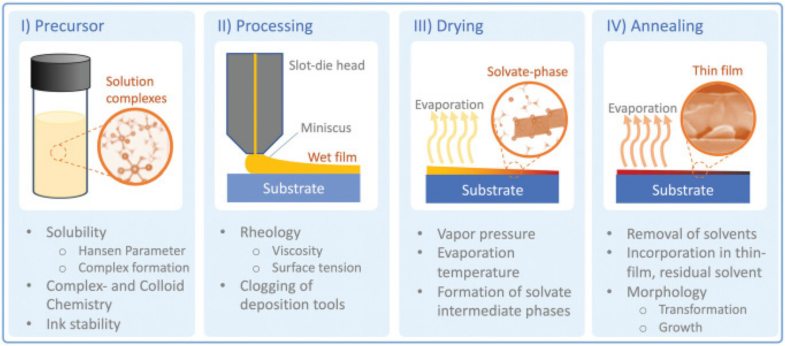
Jia Guo, Yaolin Xu, Moritz Exner, Xinrong Huang, Yongchun Li, Yanchen Liu, Hui Wang, Julia Kowal, Qi Zhang, Peter Kjær Kristensen, Deyong Wang, Kjeld Pedersen, Leonid Gurevich, Daniel-Ioan Stroe, and Philipp Adelhelm
Advanced Energy Materials (2024), DOI: 10.1002/aenm.202400190

Highlight 3: Ink Engineering for Scalable and Efficient Perovskite Solar Modules

Transitioning perovskite solar cells from laboratory-scale to industrial production has been a major hurdle in the field of renewable energy. This study addresses that challenge by introducing a specially designed ink formulation that enables high-performance perovskite solar cells to be fabricated using scalable slot-die coating techniques. The researchers achieved power conversion efficiencies exceeding 22% in small-area cells, as well as remarkable operational stability in outdoor tests of mini-modules over the course of an entire year.



Comparison of two precursor inks: (a) 0% ACN and (b) 46% ACN mix. (ii) shows the as-coated wet films, (iii) sketches the meniscus and ribbing, (iv) the annealed films, and (v) SEM top and cross-section images after annealing.



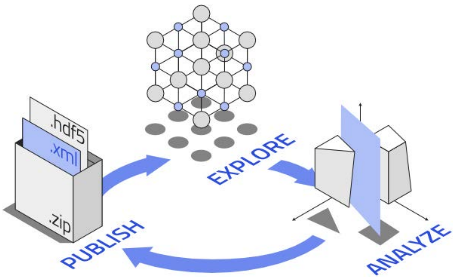
This illustration shows how solvents are used in making thin films by solution methods.

The key innovation lies in tuning the rheology and crystallization dynamics of the ink to enable uniform film formation at room temperature, a significant step forward from traditional spin-coating methods used in laboratories. The researchers combined material chemistry, process engineering, and interface optimization to ensure that the perovskite layers form homogeneously and adhere well to underlying substrates.

By demonstrating compatibility with roll-to-roll processing and achieving long-term device durability, this work offers a blueprint for mass-manufacturable perovskite photovoltaics. For the CSMB, this research embodies the center's strategic aim to bridge basic materials science and real-world technologies. It also strengthens CSMB's expertise in printable hybrid materials and sustainable energy solutions.

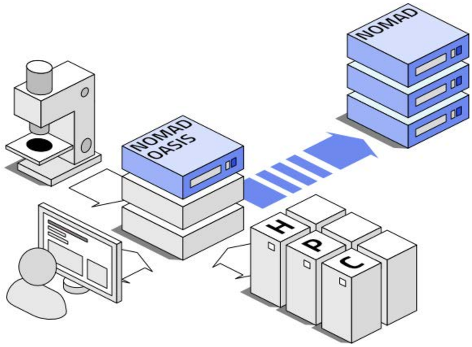
Jinzhao Li, Janardan Dagar, Oleksandra Shargaieva, Oliver Maus, Marco Remec, Quiterie Emery, Mark Khenkin, Carolin Ulbrich, Fatima Akhundova, José A. Márquez, Thomas Unold, Markus Fenske, Christof Schultz, Bert Stegemann, Amran Al-Ashouri, Steve Albrecht, Alvaro Tejada Esteves, Lars Korte, Hans Köbler, Antonio Abate, Daniel M. Többens, Ivo Zizak, Emil J. W. List-Kratochvil, Rutger Schlatmann, and Eva Unger Schlatmann, and Eva Unger
Advanced Energy Materials (2023), DOI: 10.1002/aenm.202203898

Highlight 4: NOMAD – A Platform for Open, FAIR Materials Data



The NOMAD (NOvel MAterials Discovery) platform represents a major step forward in how materials science data is organized, shared, and reused. Developed by a consortium of researchers including CSMB scientists, NOMAD provides a distributed and web-based solution for data management, tailored to the needs of modern materials research. As data volumes grow and interdisciplinary projects become the norm, such platforms are essential for maintaining transparency, reproducibility, and collaboration across institutions and scientific disciplines.

NOMAD functions as both a data repository and an electronic lab notebook. It supports a wide variety of input formats from simulations and experiments, automatically extracts rich metadata, and allows for structured data entry using customizable forms. Data can be stored privately, shared within teams, or published to a public repository — all while complying with the FAIR principles (Findable, Accessible, Interoperable, Reusable). This empowers researchers to keep their data usable not just during a project, but far beyond its immediate publication window.



Of particular importance is NOMAD's ability to connect each distributed (local) installation, a so-called NOMAD OASIS, across institutions. This decentralized model ensures flexibility in how data is stored and protected, while still allowing global interoperability. NOMAD is also integrated with tools for machine learning and high-throughput analysis, enabling automated workflows and facilitating new discoveries through AI. Its foundational role in the NFDI consortium FAIRmat further cements its impact on national and European research infrastructures.

At the CSMB, NOMAD is a crucial enabler of data-centric science. It allows materials datasets generated across joint labs and experimental platforms to be systematically captured and shared. This supports open science and ensures that the center's research remains not only cutting-edge but also accessible, reproducible, and thus paves the way for a future of digital materials discovery.

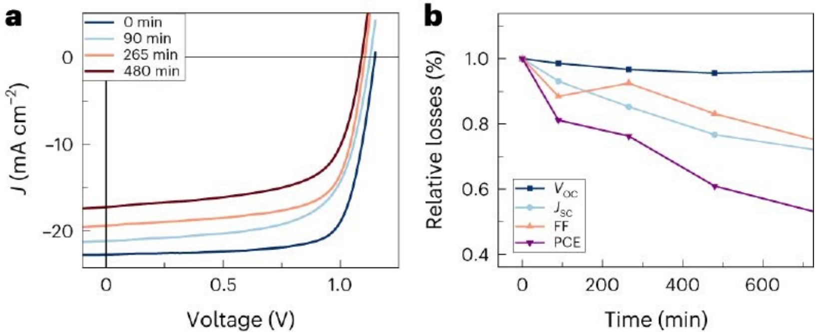
Markus Scheidgen, Lauri Himanen, Alvin Noe Ladines, David Sikter, Mohammad Nakhaee, Ádám Fekete, Theodore Chang, Amir Golparvar, José A. Márquez, Sandor Brockhauser, Sebastian Brückner, Luca M. Ghiringhelli, Felix Dietrich, Daniel Lehmberg, Thea Denell, Andrea Albino, Hampus Näsström, Sherjeel Shabih, Florian Dobener, Markus Kühbach, Rubel Mozumder, Joseph F. Rudzinski, Nathan Daelman, José M. Pizarro, Martin Kuban, Cuauhtemoc Salazar, Pavel Ondračka, Hans-Joachim Bungartz, and Claudia Draxl
Journal of Open Source Software (2023), DOI: 10.21105/joss.05388

Highlight 5: Ion Dynamics in Perovskite Solar Cells Revealed

Perovskite solar cells have reached record-breaking efficiencies, but their long-term operational stability remains a major hurdle for commercialization. This study provides crucial insight into one of the most elusive aspects of perovskite solar cells: ion migration. The researchers show how the motion of ions within the perovskite layer can lead to redistribution of internal electric fields, thereby influencing device performance and stability over time.

Using a combination of transient electrical measurements, electrostatic potential mapping, and device modeling, the team quantifies the extent and timescales of ion motion. They observe that mobile ions can partially or fully screen the built-in electric field in operating devices. This ionic screening can reduce charge collection efficiency and accelerate degradation, particularly under continuous light exposure.

Importantly, the researchers demonstrate that adjusting the composition of the perovskite layer and the choice of contact materials can help control ionic motion. By suppressing the migration of specific ions, it becomes possible to preserve the desired electric field configuration and reduce hysteresis effects. The study thus provides both a diagnostic framework and actionable design rules for more stable perovskite solar cells.



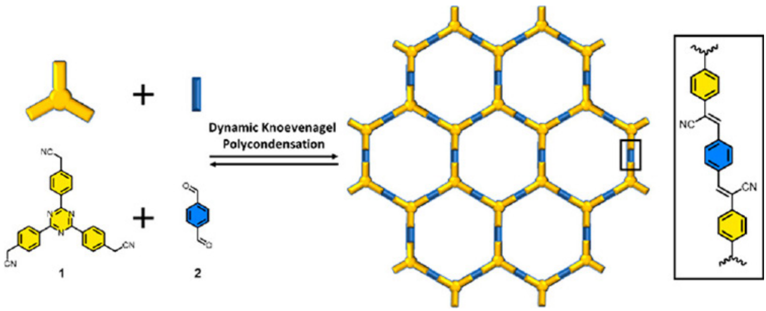
a) Representative stabilized J–V characteristics at slow scan speeds (10 mV s^{-1}) measured on a fresh perovskite solar cell as well as after continuous illumination at open-circuit voltage for the specified time.
b) Relative steady-state losses of the different power conversion efficiency parameters as a function of aging time.

This work resonates strongly with the CSMB's mission to support sustainable energy technologies and advance our understanding of complex hybrid materials. It also highlights the value of cross-disciplinary collaboration between materials science, physics, and device engineering in tackling critical bottlenecks in energy conversion technologies.

Jarla Thiesbrummel, Sahil Shah, Emilio Gutierrez-Partida, Fengshuo Zu, Francisco Peña-Camargo, Stefan Zeiske, Jonas Diekmann, Fangyuan Ye, Karol P. Peters, Kai O. Brinkmann, Pietro Caprioglio, Akash Dasgupta, Seongrok Seo, Fatai A. Adeleye, Jonathan Warby, Quentin Jeangros, Felix Lang, Shuo Zhang, Steve Albrecht, Thomas Riedl, Ardalan Armin, Dieter Neher, Norbert Koch, Yongzhen Wu, Vincent M. Le Corre, Henry Snaith, and Martin Stolterfoht
Nature Energy (2024), DOI: 10.1038/s41560-024-01487-w

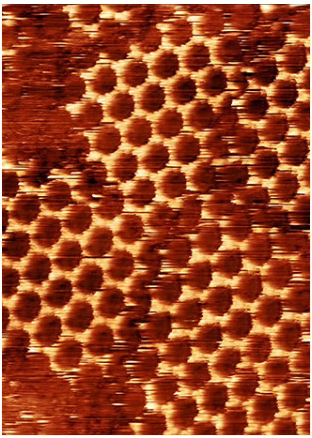
Highlight 6: On-Surface Synthesis of Atomically Thin Organic Frameworks

Covalent organic frameworks (COFs) are a promising class of crystalline, porous materials built entirely from light elements like carbon, hydrogen, nitrogen, and oxygen. This study reports a significant breakthrough in the bottom-up fabrication of 2D COFs demonstrating the synthesis of a vinylene-linked single-layer framework directly on a solid surface - at room temperature.



By employing a carefully selected precursor design and surface-mediated polymerization, the authors achieved full conversion into an extended, atomically thin network. High-resolution scanning tunneling microscopy confirmed the long-range order and uniformity of the resulting film. This work overcomes a long-standing challenge in COF chemistry — maintaining both planarity and stability in ultra-thin organic networks assembled under mild conditions.

Importantly, the method relies on surface-confined reactions that avoid bulk-phase interference, thereby enabling spatial control over the growth and orientation of the material. Such COFs are of particular interest for molecular electronics, catalysis, sensing, and even quantum information processing due to their tunable electronic and mechanical properties.



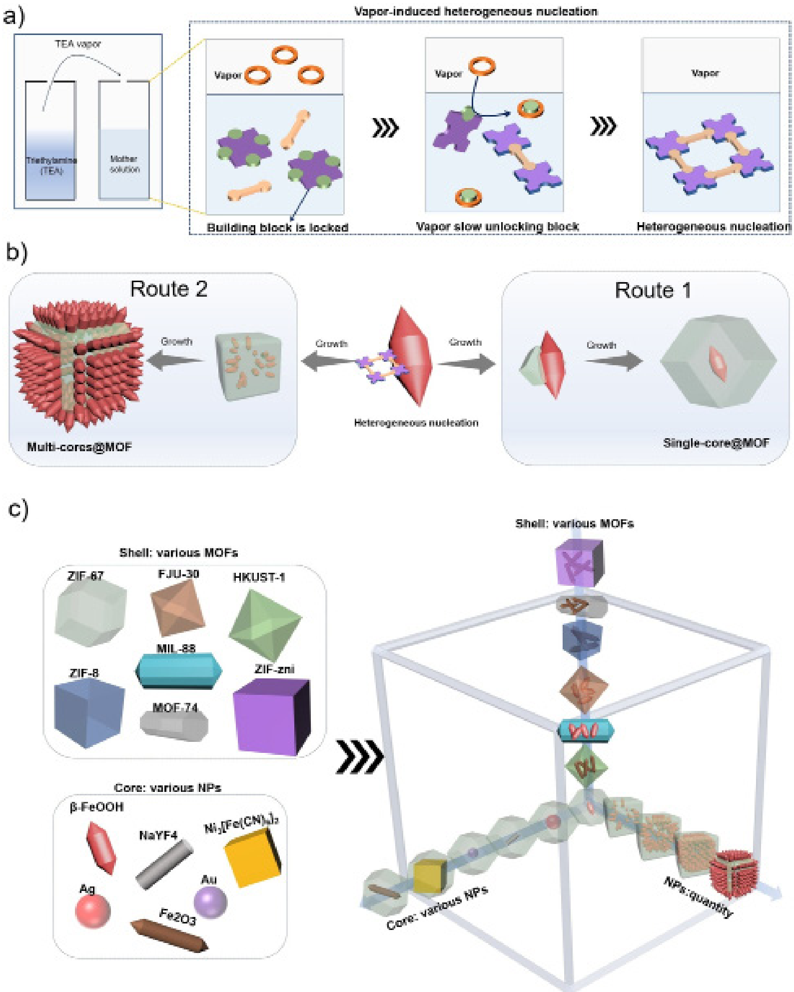
This achievement represents a fusion of synthetic organic chemistry and surface science and is highly aligned with the interdisciplinary approach promoted at CSMB. It highlights the potential of rational molecular design in creating functional materials with atomic precision. Furthermore, this research strengthens CSMB's profile in low-dimensional systems and paves the way for collaborations across physics, chemistry, and nanotechnology in the area of designer materials.

Filippo Giovanni Fabozzi, Nikolai Severin, Jürgen P. Rabe, and Stefan Hecht
Journal of the American Chemical Society (2023), DOI: 10.1021/jacs.3c04730

Highlight 7: A Universal Route to Metal–Organic Framework Nanohybrids

Metal–organic frameworks (MOFs) are porous, crystalline materials that have become indispensable in materials science due to their exceptional modularity, tunability, and wide application potential - from catalysis and separation to sensing and energy storage. However, integrating MOFs with nanoparticles (NPs) to create nanohybrids—composites that combine the functionality of both components—has historically been limited by strict compatibility requirements between the MOF and the core material.

This study reports a groundbreaking and universal synthesis strategy for creating tunable MOF nanohybrids with a wide variety of core and shell combinations. The innovation lies in using triethylamine vapor to slowly deprotonate organic ligands in solution, which in turn initiates controlled nucleation and growth of the MOF shell directly around the nanoparticle cores. This diffusion-driven process makes it possible to uniformly encapsulate diverse cores, ranging from Ag, Au, and $NaYF_4$ to iron oxide nanorods, inside MOF shells like ZIF-8, HKUST-1, and MIL-88.



A universal strategy for MOF nanohybrids.

a) Triethylamine vapor diffuses into the mother solution (MOF precursors, nanoparticles (NPs), and solvent), releases locked ligands and drives nucleation.

b) Scheme diagram of constructing single-core@MOF (induced by weaker coordinating anion like NO_3^-) and multi-cores@MOF, induced by strong coordinating anion (Cl^-)

c) 3D models of the NPs, MOFs, & nanohybrids.

What sets this method apart is its exceptional flexibility and precision:

- It works without any specific surface functionality or lattice match between core and shell.
- It enables the encapsulation of a tailored number of cores, from single particles to clusters, simply by tuning the vapor diffusion rate or the coordinating strength of the metal precursor's counterion (e.g., switching from nitrate to chloride).
- It allows the construction of binary, ternary, and even quaternary nanohybrids, where multiple types of nanoparticles coexist within a single MOF shell.

This method represents a powerful tool for materials design. It offers a combinatorial approach to the creation of complex, functional hybrid materials, enabling tailored properties for specific applications. At the CSMB, this aligns closely with research on hybrid systems, interface design, and scalable nanomaterials for catalysis, photonics, and beyond. It also exemplifies the interplay of synthetic chemistry, nanotechnology, and process control that defines next-generation materials innovation.

Wei Zhang, Michael J. Bojdys, and Nicola Pinna
Angewandte Chemie International Edition (2023), DOI: 10.1002/anie.202301021

Foundations for the Future: Research Building

The successful completion and gradual commissioning of the research building in early 2021 marked a major step in establishing a cutting-edge infrastructure for interdisciplinary materials research in Adlershof. Initially conceived within the IRIS Adlershof framework, the facility has since become an integral part of the Center for the Science of Materials Berlin (CSMB), continuing and expanding the vision of fostering collaboration between physics, chemistry, and materials science.

The research building comprises 2500 m² of laboratory space, 2200 m² of office space, and several common areas. At its core, the building offers laboratories of varying sizes and specifications, ranging from standard physics laboratories with shared media supply and wet laboratories with multiple hoods, to clean rooms and high-quality optical laboratories with controlled climatic conditions, as well as magnetically shielded and vibration-decoupled facilities. The basement hosts high-end laboratories for state-of-the-art transmission electron microscopy (TEM), equipped with advanced vibration isolation and magnetic shielding.

Adjacent to the laboratories are offices providing over 180 workspaces. Their proximity supports close interaction among scientists while shared meeting zones create opportunities for informal exchange. Researchers from diverse fields, physicists and chemists, theoreticians and experimentalists, thus benefit from a collaborative environment. Several seminar rooms support discussions, presentations, and lectures, while the entrance area allows for poster sessions, making the building well suited for scientific meetings and conferences.

The laboratories house a wide range of advanced instruments enabling fabrication and characterization across many scales. Facilities include equipment for wet and vacuum processing, printing, as well as numerous spectroscopies and microscopies. A highlight is the NION high-resolution TEM with an ultrahigh resolution energy filter, capable of imaging atomic structures and performing vibrational spectroscopy. Additional TEMs, including a cryo-TEM and various scanning electron microscopes complement this setup. A dedicated clean-room features tools for photo- and electron-beam lithography and scanning probe microscopes. The core of the research building is equipped with a 19 m glovebox cluster and an ultra-high-vacuum cluster for device fabrication and characterization.

BIO-S1 and BIO-S2 certified wet labs, along with diverse measurement rooms, provide flexible environments for short-, mid-, and long-term research in both individual and shared use.

Together through Shared Infrastructure:
Joint Labs

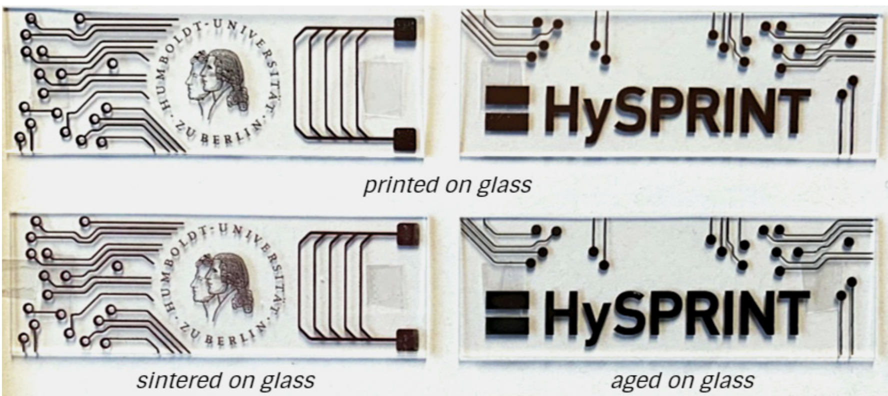
A defining feature of the CSMB is its strategic use of shared research infrastructure through Joint Labs – cooperative platforms operated in close collaboration with partner institutions across Berlin's vibrant science landscape. These labs reflect the CSMB's commitment to inter-institutional integration and its holistic approach to materials research, where synthesis, characterization, processing, and theory are not only co-located but deeply intertwined.

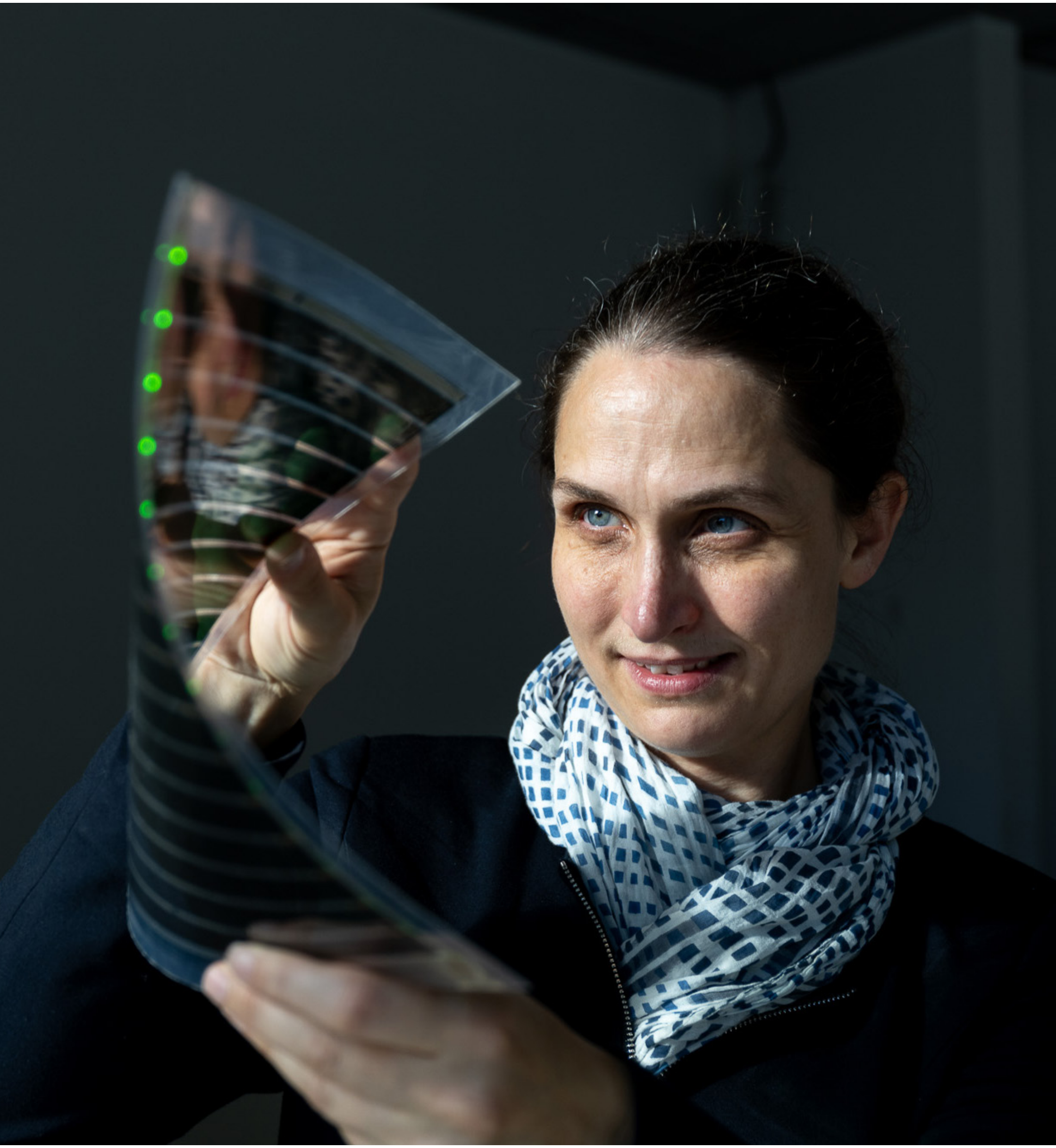
By pooling expertise and resources from Humboldt-Universität zu Berlin, the Helmholtz-Zentrum Berlin, the Leibniz-Institut für Kristallzüchtung, the Fritz-Haber-Institut of the Max Planck Society, and others, the Joint Labs enable access to world-class equipment, foster joint training environments, and accelerate innovation across disciplinary boundaries. Each lab operates with a focused thematic agenda – from printable electronics to catalysis and quantum materials – and plays a critical role in implementing the CSMB's mission to bridge fundamental science and technological application.

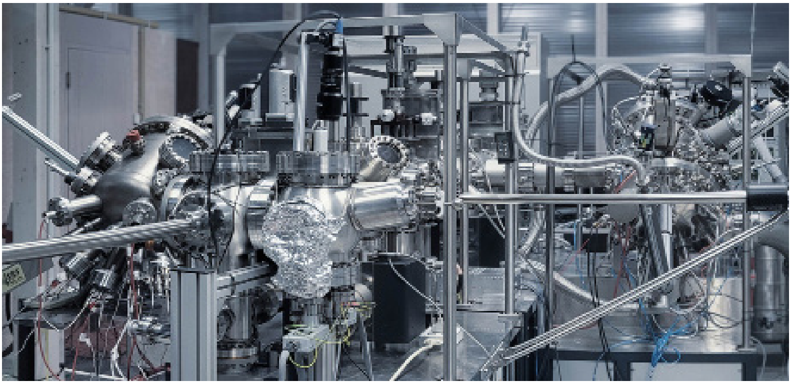
GenFab – Generative Manufacturing for Hybrid Components

GenFab focuses on the scalable fabrication of hybrid electronic and optoelectronic devices using additive manufacturing techniques such as inkjet and spray printing. The lab combines expertise in printable semiconductors, ink formulation, and device prototyping to accelerate the development of flexible and low-cost technologies for photovoltaics, memory, and sensor applications. GenFab exemplifies how close integration between university research and large-scale infrastructure at HZB enables rapid translation from lab-scale materials synthesis to near-industrial process development.

- Partner: Helmholtz-Zentrum Berlin
- Coordinators: Emil List-Kratochvil & Eva Unger







JL-2DSES – Joint Lab for 2D Materials and Electron Spectroscopy

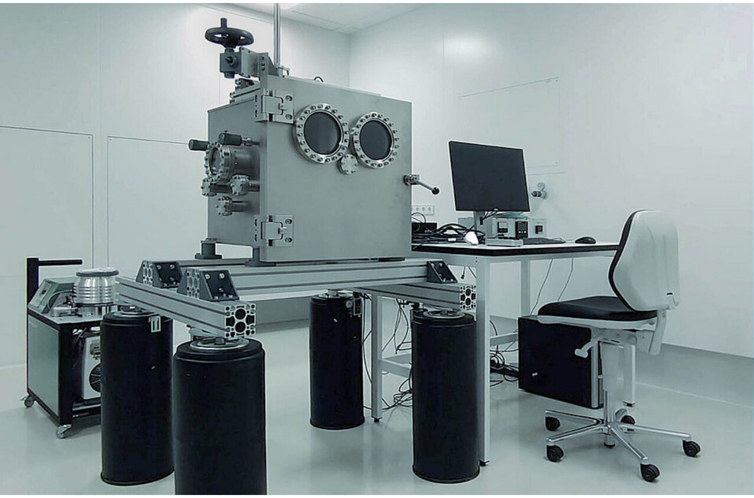
This lab provides a unique platform for the synthesis and spectroscopic analysis of two-dimensional materials using molecular beam epitaxy and photoelectron spectroscopy. JL-2DSES supports the growth of ultrathin layers with controlled interfaces and allows in-depth characterization of electronic band structures. It connects fundamental surface physics with emerging applications in electronics and quantum technologies and enables close collaboration between the CSMB and one of Germany's leading centers for crystal growth.

- Partner: Leibniz-Institut für Kristallzüchtung
- Coordinator: Norbert Koch

Layer Transfer for 2D Hetrostructures

The continued development of functional quantum materials is a key research priority, both at the national level and within the CSMB. Among these, two-dimensional materials, such as graphene and transition metal dichalcogenides, offer exceptional properties, but often reveal their full potential only when assembled into custom-designed heterostructures. This Joint Lab is dedicated to developing advanced techniques for layer transfer, enabling the assembly of high-quality 2D material stacks with tailored interfaces and aligned crystal orientations. The goal is to fabricate and analyze novel heterostructures for applications in quantum technologies, optoelectronics, and neuromorphic computing.

- Partner: Leibniz-Institut für Kristallzüchtung
- Coordinators: Sylke Blumstengel & Jens Martin




Joint Catalysis Lab

The Joint Catalysis Lab housed in the CSMB research building focuses on the in-situ and operando investigation of thin-film catalytic systems. It combines capabilities in film deposition, surface analysis, and advanced electron microscopy to study chemical reactions at active interfaces. Located in proximity to the BeAM microscopy center, the lab facilitates high-resolution imaging of catalyst structures during operation. This research contributes directly to the CSMB's goals in energy materials and sustainable catalysis.

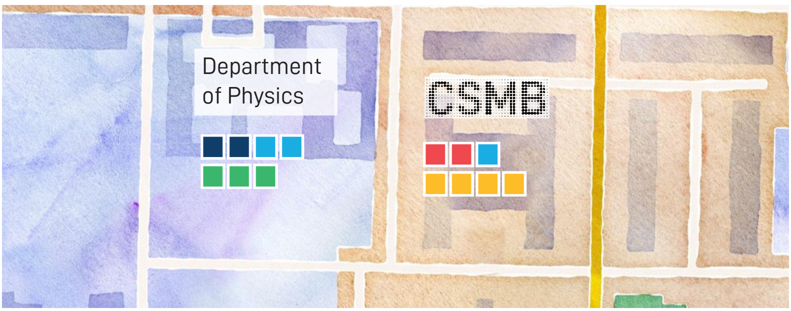
- Partners:
  Helmholtz-Zentrum Berlin,
  Fritz Haber Institute of the Max Planck Society
- Coordinator: Karsten Reuter, Beatriz Roldán Cuenya, Rutger Schlatmann

BeAM
ADLERSHOF

Berlin-Adlershof Center for Advanced Microscopy

BeAM serves as the central microscopy hub of the CSMB, offering cutting-edge transmission electron microscopy (TEM), scanning electron microscopy (SEM), and scanning probe techniques. The facility is equipped for in-situ and cryo-capable imaging, enabling studies of material structure and functionality at the atomic level. Through shared instrumentation and method development, BeAM supports multiple CSMB research areas from quantum materials to catalysis and printed electronics.

- Partners:
  Helmholtz-Zentrum Berlin,
  Fritz Haber Institute of the Max Planck Society,
  Leibniz-Institut für Kristallzüchtung,
- Coordinator: Christoph T. Koch



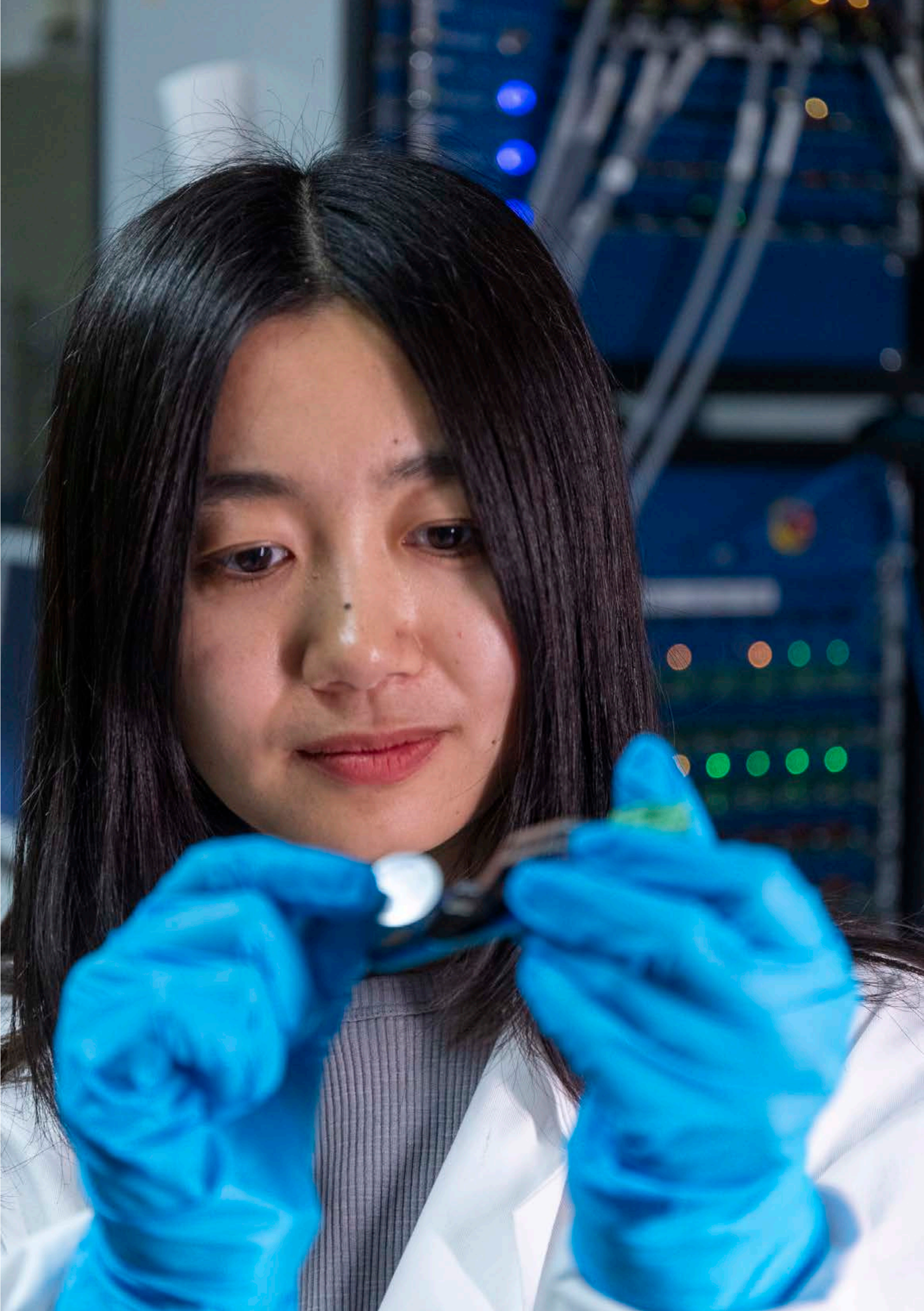
TEMs & SEMs of the center by provider:
CSMB, Department of Physics, IKZ, HZB, FHI,

BBL – Berlin Battery Lab

BBL brings together HU, HZB, and BAM to accelerate research on sustainable battery technologies, including sodium-ion, lithium–sulfur, and sodium–sulfur systems. The lab combines materials synthesis, electrochemistry, safety testing, and operando diagnostics to address performance, scalability, and resource efficiency. A key focus is on Prussian blue analogues, where all three partners contribute complementary expertise to evaluate their potential as next-generation storage materials. BBL strengthens Berlin's position as a hub for battery research and exemplifies institutional cooperation in mission-driven energy science.
It reflects the CSMB's commitment to sustainable materials and collaborative innovation for energy transition technologies.

- Partners:
  Bundesanstalt für Materialforschung und -prüfung,
  Helmholtz-Zentrum Berlin,
  Humboldt-Universität zu Berlin (HU)
- Coordinator: Philipp Adelhelm

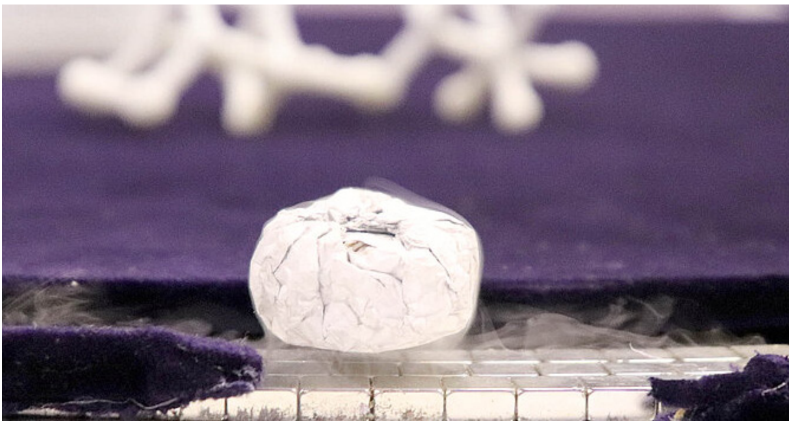
G. Graeber, F. Wille, P. Adelhelm, U. Panne, C. Schneider B. Rech, T. Frederking, Y. Lu and T.-P. Fellinger signing the Memorandum of Understanding; Photo: Uta Sommer, HU



JAMA – Joint Laboratory for Advanced Magneto-Transport Adlershof

JAMA explores the electronic transport properties of semiconductors and oxide materials under extreme conditions such as low temperatures and high magnetic fields. It provides access to custom measurement setups and cryogenic infrastructure for probing phenomena like quantum Hall effects, topological states, and interface conductivity. By linking IKZ's materials growth capabilities with the CSMB's expertise in condensed matter physics, JAMA forms a vital platform for quantum material research and neuromorphic device exploration.

- Partner: Leibniz-Institut für Kristallzüchtung
- Coordinators: Saskia Fischer & Andreas Fiedler



Awards that Reflect Dedication:

Success Stories

The CSMB is not just a hub for excellent research, it is a place where careers are launched, ideas become innovations, and collaborative efforts shape the future of materials science. In the last years, members of the CSMB network have been honored with a series of prestigious awards and distinctions, reflecting the center's strong academic reputation, societal relevance, and contribution to the national and international research landscape. In this section we like to highlight a few of them:

Philipp Adelhelm – Berlin Science Award 2025

Philipp Adelhelm was awarded the Berlin Science Award 2025 by the Governing Mayor of Berlin. This prestigious prize honors researchers who have made outstanding contributions to strengthening Berlin as a hub for scientific excellence and innovation.

He leads a joint research group between HU Berlin and Helmholtz-Zentrum Berlin (HZB) and is recognized internationally as one of the foremost experts in the field of sodium-ion batteries. As a materials scientist & electrochemist, he explores the development of sustainable, safe, and cost-effective battery systems, technologies that will be central to the success of the energy transition.

The jury praised his research for offering groundbreaking and internationally influential contributions to the future of energy supply, while also reinforcing Berlin's scientific leadership in electrochemistry and sustainability research.

In his own words, Prof. Adelhelm sees the award as recognition of a deeply collaborative and interdisciplinary effort:
"I am delighted to receive this award in recognition of our joint work on more sustainable batteries – an interdisciplinary project that we are carrying out in Berlin across the boundaries of several scientific institutions. The further development of cost-effective and safe electricity storage systems, for example, for electric vehicles, home or large-scale storage facilities, is a central element of the energy transition and security of supply. It is one of the major challenges facing chemistry and other STEM subjects. I would like to express my special thanks to my team and our cooperation partners – especially at the science location Berlin, which, with its unique density of research institutions, is

an ideal place for
innovative materials research."

He also received the ISSI Mid-Career Researcher Award in order to recognize his leadership and innovation in the field of solid state ionics in 2024. In 2025 he co-launched the Berlin Battery Lab, where he serves as coordinator.
His recognition as a leading figure in battery research affirms the center's strategic focus on energy materials, data-driven science, and interdisciplinary collaboration.

Kristin Klaue – Dissertationspreis Adlershof 2024

Early-career researchers play a crucial role in the vitality of the CSMB. One such success story is Dr. Kristin Klaue, who was awarded the Adlershof Dissertation Prize in 2025 for her exceptional doctoral thesis conducted within the interdisciplinary environment of the CSMB in the group of Prof. Stefan Hecht. Her research focuses on light-controlled release systems—an approach that opens new frontiers in biomedical applications and smart therapeutics.

“Above all, I’m driven by curiosity.”

Light offers unique opportunities for the targeted, non-invasive control of biological processes, enabling precise interventions at the molecular level. Inspired by Paul Ehrlich's concept of the "Magic Bullet", an agent that can eliminate pathogens without harming healthy tissue, Dr. Klaue developed photoresponsive molecular units that can be activated by harmless infrared light to trigger the controlled release of active substances. This technology lays the foundation for a new class of phototherapeutics and innovative biomedical tools, including 3D printing directly within living tissue.

Her dissertation stands at the intersection of synthetic chemistry, photophysics, and biomedicine, and exemplifies how materials research at the CSMB transcends disciplinary boundaries to address real-world challenges.

In addition to Dr. Kristin Klaue, two other outstanding researchers presented their work in the final round. Dr. Jinzhao Li, supervised by CSMB member Prof. Eva Unger, developed novel inks that enable the mass production of a new generation of solar cells. Dr. Beñat Alberdi Esuain achieved groundbreaking advances in electron optics and beam dynamics.

Awarded jointly by WISTA Management GmbH, IGAFA e.V., and the Humboldt-Universität, the prize is one of Berlin's most competitive honors for doctoral research. It recognizes not only scientific excellence but also relevance, innovation, and the ability to engage with broader societal challenges.

Stefan Hecht – UNIPRENEURS Award 2023

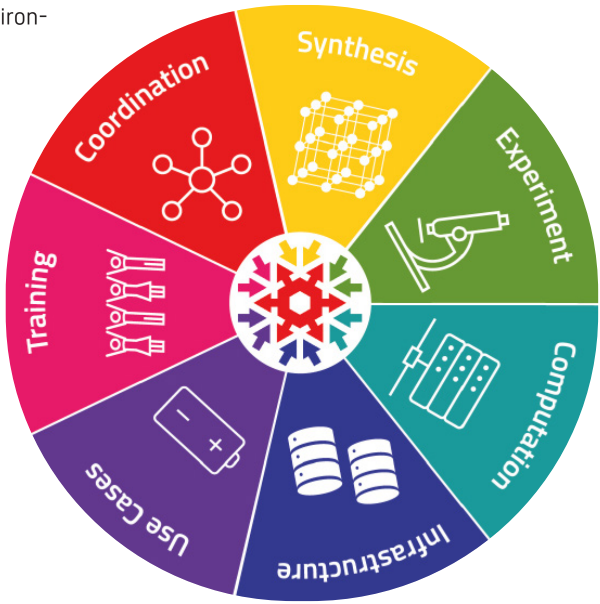
Stefan Hecht, founding director of the CSMB and Einstein Professor of Chemistry at HU Berlin, was honored with the UNIPRENEURS Award 2023. Selected from over 700 nominations, Hecht was recognized for his outstanding engagement in supporting academic entrepreneurship and technology transfer.

Beyond his renowned work in molecular switches and responsive materials, Hecht has mentored spin-offs and promoted a culture of innovation within the academic sphere. His role as a bridge-builder between fundamental research and application aligns perfectly with the CSMB's mission. The award affirms the center's strategic positioning at the interface of science, technology, and entrepreneurship.

FAIRmat – National Research Data Infrastructure Initiative

One long-term success story of the CSMB is the project FAIRmat (FAIR data infrastructure for condensed-matter physics and chemistry), led by Prof. Claudia Draxl and co-led by Prof. Christoph Koch. Established in 2021, FAIRmat has become one of the most successful project consortia within the German National Research Data Infrastructure (NFDI). The initiative provides tools, standards, and platforms for ensuring that data generated in materials research are FAIR: Findable, Accessible, Interoperable, and Reusable.

Headquartered at the CSMB and closely linked with its research environment, FAIRmat strengthens the digital backbone of modern materials science. It not only enables data-driven discovery but also fosters a culture of reproducibility and open science, values that are core to the CSMB's mission. The project has attracted international interest and serves as a model for data infrastructure in other scientific domains.



Eva Unger – Helmholtz High Impact Award 2023

Eva Unger, Professor at HU Berlin and group leader at Helmholtz-Zentrum Berlin and co-director of the CSMB Joint Lab GenFab, received the Helmholtz High Impact Award in recognition of her work on next-generation tandem solar cells based on perovskite materials. The award, which highlights research with tangible impact beyond academia, reflects both the scientific ambition and the translational power of her work.

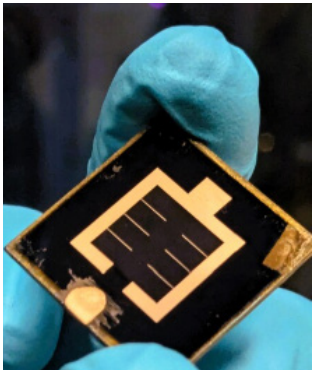
Her research focuses on developing scalable processes for highly efficient solar cells and integrating in-operando diagnostics to ensure real-world performance and stability. As one of the leading figures in printable optoelectronics in Germany, her work strengthens the CSMB's energy materials portfolio and exemplifies successful collaboration between university and large-scale research infrastructure.

Claudia Draxl – Elected to Leopoldina 2025

In 2025, Claudia Draxl was elected a member of the German National Academy of Sciences Leopoldina, the oldest continuously existing academy of natural sciences in the world. Her election honors a career of outstanding scientific contributions to theoretical solid-state physics, electronic structure theory, and data infrastructure.

As one of the intellectual architects of the CSMB, Claudia Draxl's achievements underscore the center's strength in foundational research as well as its leadership in structuring the future of scientific collaboration. Her inclusion in the Leopoldina reflects not only individual excellence but the growing national and international recognition of the CSMB community.

Emil List-Kratochvil – World Record for Printed Solar Cells 2025



In a remarkable demonstration of collaboration and innovation, a team of researchers from the CSMB at Humboldt-Universität zu Berlin and Helmholtz-Zentrum Berlin (HZB), led in part by Emil List-Kratochvil, has set a new world record in thin-film photovoltaics: a certified efficiency of 24.6% for a CIGS–perovskite tandem solar cell.

The result was officially confirmed by the independent Fraunhofer Institute for Solar Energy Systems ISE, marking a milestone in the global race toward more efficient and sustainable solar energy technologies. The record-setting cell combines a bottom cell of copper–indium–gallium–selenide (CIGS) with a perovskite-based top cell, carefully engineered to ensure optimal light absorption and charge carrier extraction.

Tandem solar cells constructed from two semiconductor layers stacked on top of one another are considered a key pathway to surpassing the efficiency limits of conventional single-junction cells. In this case, the combination of two thin-film technologies offers not only high performance but also a minimal environmental footprint, as the materials and processes involved require significantly less energy and raw material than crystalline silicon counterparts. Moreover, the CIGS layer can be deposited on flexible substrates, opening avenues for lightweight and portable solar technologies.

This achievement not only sets a new benchmark in solar cell performance but also showcases the strength of Berlin's integrated research ecosystem. The teams are now working to further optimize the tandem architecture and to scale the technology toward future applications—helping to actively shape a sustainable and secure energy supply for the coming decades.

"extraordinary results [...] can be achieved through close collaboration."

At the CSMB, this success represents a flagship result for its focus areas in printed electronics, energy materials, and hybrid systems, and underscores how collaborative infrastructure like Joint Labs can serve as accelerators of real technological breakthroughs.

Sharing Science, Building Community:
Events & Outreach

At the CSMB, we believe that excellent science does not end at the laboratory door. Sharing knowledge within our own community, with peers around the world, and with the wider public is a core part of our mission. Communication, participation, and curiosity are at the heart of our approach to research.

Our events and outreach activities serve multiple goals:

- Exchanging ideas with the global scientific community through participation of CSMB members in conference symposia, lectures, and guest talks
- Fostering internal collaboration and cohesion across disciplines and working groups within the CSMB
- Engaging with the public to raise awareness of the relevance of materials science
- Inspiring the next generation, especially young girls, to pursue careers in science and technology
- Creating space for dialogue between science, art, and society

To serve these goals, we have launched and participated in a variety of formats.

Scientific Colloquia

In our Scientific Colloquium Series, we invite internationally recognized speakers to present their latest findings and perspectives in materials science.

14. Nov. 2023, Prof. Joakim Andreasson, Chalmers
15. Feb. 2024, Prof. Arri Priimägi, Tampere University
3. Juni 2024, Prof. Jonathon E. Beves, University of New South Wales, Sydney
11. Sept. 2024, Prof. Klaus Müllen, MPI for Polymer Research, Mainz
14. Oct. 2024, Prof. Paolo Samorì, Université de Strasbourg & ISIS
12. Dec. 2024, Prof. Joakim Andréasson, Chalmers, Sweden
23. Jan. 2025, Prof. Milan Kivala, Ruprecht-Karls-Universität Heidelberg
11. Feb. 2025, Prof. Federico Rosei, Università degli Studi di Trieste
12. Feb 2025, Prof. Federico Rosei, Università degli Studi di Trieste
4. April 2025, Prof. Robert Göstl, Bergische Universität Wuppertal
11. April 2025, Prof. Daniel Maspoch, Universitat Autònoma de Barcelona & ICN2
14. May 2025, Prof. Frederik Haase, Martin-Luther-Universität Halle-Wittenberg
22. July 2025, Prof. Fabian Eisenreich, Technische Universiteit Eindhoven
16. July 2025, Prof. Egbert Meijer, Technische Universiteit Eindhoven
13. Oct. 2025, Prof. William Dichtel, Northwestern University

Meet the Neighbour

The format "Meet the Neighbour" offers CSMB working groups the opportunity to introduce themselves to other members, promoting internal visibility, networking, and collaboration.

26. February 2024, CatLab
10. April 2024, AtomLab (AG Palma)
29. May 2024, CSMB Meets Arts (Sabine Wrabetz, Candy Lenk, and Collin Dey)
5. November 2024, Structure Research & Electron Microscopy (AG CT Koch)
4. February 2025, SOLgroup (AG Draxl)

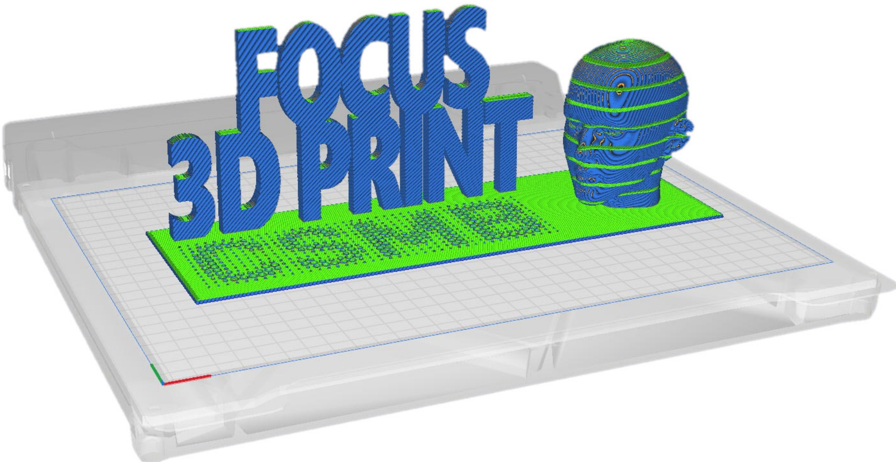
The special event *CSMB meets Art* brought science and creativity together in an engaging way.
Sabine Wrabetz, a researcher based in the CSMB building, presented a selection of her paintings in the foyer, revealing how scientific work can spark artistic expression. Her pieces drew inspiration both from her research and from the building's existing art-in-architecture installation Zugänge. The installation's creator, Candy Lenk, opened the exhibition with a thoughtful introduction, while DJ Collin van Dey provided the musical setting for the evening.

Girls Day –
Inspiring Future Scientists

At Girls' Day 2024 and 2025, the CSMB, together with the Department of Physics, welcomed 15 young women to explore the exciting world of materials science, from organic semiconductors to advanced experimental techniques. Our member Prof. Saskia F. Fischer and other female scientists introduced participants to cutting-edge research, while exclusive lab tours offered a rare glimpse behind the scenes.
These collaborative events sparked curiosity and inspired the next generation of scientists to shape the future of science and technology.

FOCUS EVENT

In 2024 we launched the FOCUS EVENTs, a series designed to connect scientific insight with broader societal and industry perspectives. Each event invites participants from academia, business, and the public to discuss emerging technologies, current challenges, and their implications, fostering dialogue across disciplines and sectors.



FOCUS 3D PRINT inaugurated this series, showcasing advances in additive manufacturing, novel material strategies, and 3D prototyping for research and industry. Talks by a Venture Partner and an Innovation Manager, alongside pitch sessions from researchers, practitioners, and local startups, sparked lively discussions and informal exchanges.
The event highlighted the fast pace of the field and the value of cross-sector collaboration, positioning the CSMB as a catalyst for ideas, partnerships, and innovation within Berlin's 3D-printing ecosystem.

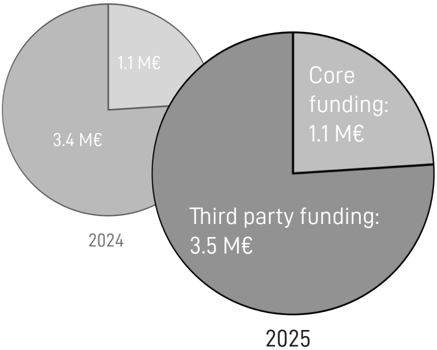
Lange Nacht der Wissenschaften

The CSMB quickly became a major attraction at the "Long Night of Science" ("Lange Nacht der Wissenschaften"). Visitors could join tours of various laboratories, where our scientists patiently answered their curious questions. In the foyer, several research groups showcased their work, complemented by short presentations. For children, the hands-on experiments "The Fabulous Kids' Lab" and "Sweet Layers" were particular highlights.

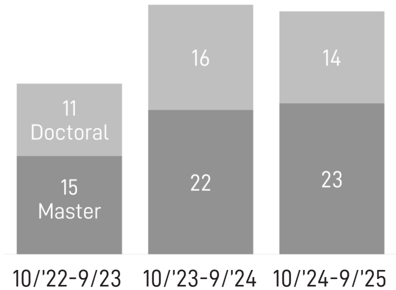

Magician

At a Glance:
Facts & Figures

Funding Acquisition



Supervised Degrees



343 scientists work at CSMB

275 articles and reviews since founding

12 825 cups of coffee drunk

Imprint

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Phone:	+49 30 2093 66350
Web:	https://csmb.hu-berlin.de/