An illustration of a modern office environment. Several people are seated at long wooden desks, working on laptops. The office has large windows in the background, and the overall color palette is muted, with blues, greys, and browns. The text is overlaid on the left side of the image.

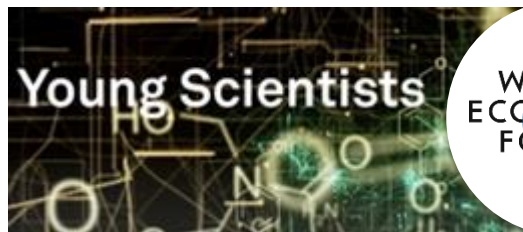
Why AI is making traditional education, research and business models obsolete

AND WHAT CAN BE DONE ABOUT IT

Prof. Dr. Michael J. Bojdys

<http://bojdyslab.org/>
m.j.bojdys.02@cantab.net





WORLD
ECONOMIC
FORUM

"The missing link of science in policy
– 1M scientists could be part of the
answer"

Cooperation via „Ausschuss für
Bildung, Forschung und
Technikfolgenabschätzung“



Deutscher
Bundestag

ERNST DIETER
ROSSMANN
SPD

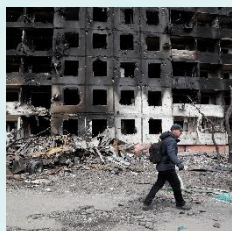
THOMAS
SATTELBERGER
FDP

Installation of the
online platform
"Disinfectant
Emergency Supply"



BERTHOLD
WELLING
Director VCI

PETER
SCHREINER
President GDCh



Installation of an
"Early Career
Advisory Board
(ECAB)" at GDCh

POLICY



МІНІСТЕРСТВО
ОСВІТИ І НАУКИ
УКРАЇНИ

YEVHENIIA
Ministry of Education
and Science (UA)

Cooperation on
"Ukraine digital"
(DAAD/BMBF)

CHRISTIAN
STROWA
DAAD

DAAD

ACADEMIA

Publication on DEI
by scientists for scientists

TOMISLAV
FRISCIC
WEF YS

JODIE
LUTKENHAUS
WEF YS

SAFIA JILANI
ISAIHA SPEIGHT
CESAR URBINA-BLANCO
Young Science Advocates

FRASER
STODDART
Nobel Laureate
2016

MICHAEL J.
BOJDYS
Functional
Nanomaterials

WEF,
Genshagener Kreis e.V.

MAGDALENA
SKIPPER
Chief-ed Nature

STUART
CANTRILL
Chief-ed Nature
Chemistry

Coordination of policy
publications on (i) DEI, (ii)
"system relevance" of
universities

MARCIN
RATAJCZAK
CEO Inuru GmbH



R&D
Smart packaging and
energy storage

INDUSTRY

STEFAN
KOLLER
MD VARTA
Micro Innovation
GmbH

R&D
Battery scale-up



MANIT



"A diverse view
of science to
catalyse
change"

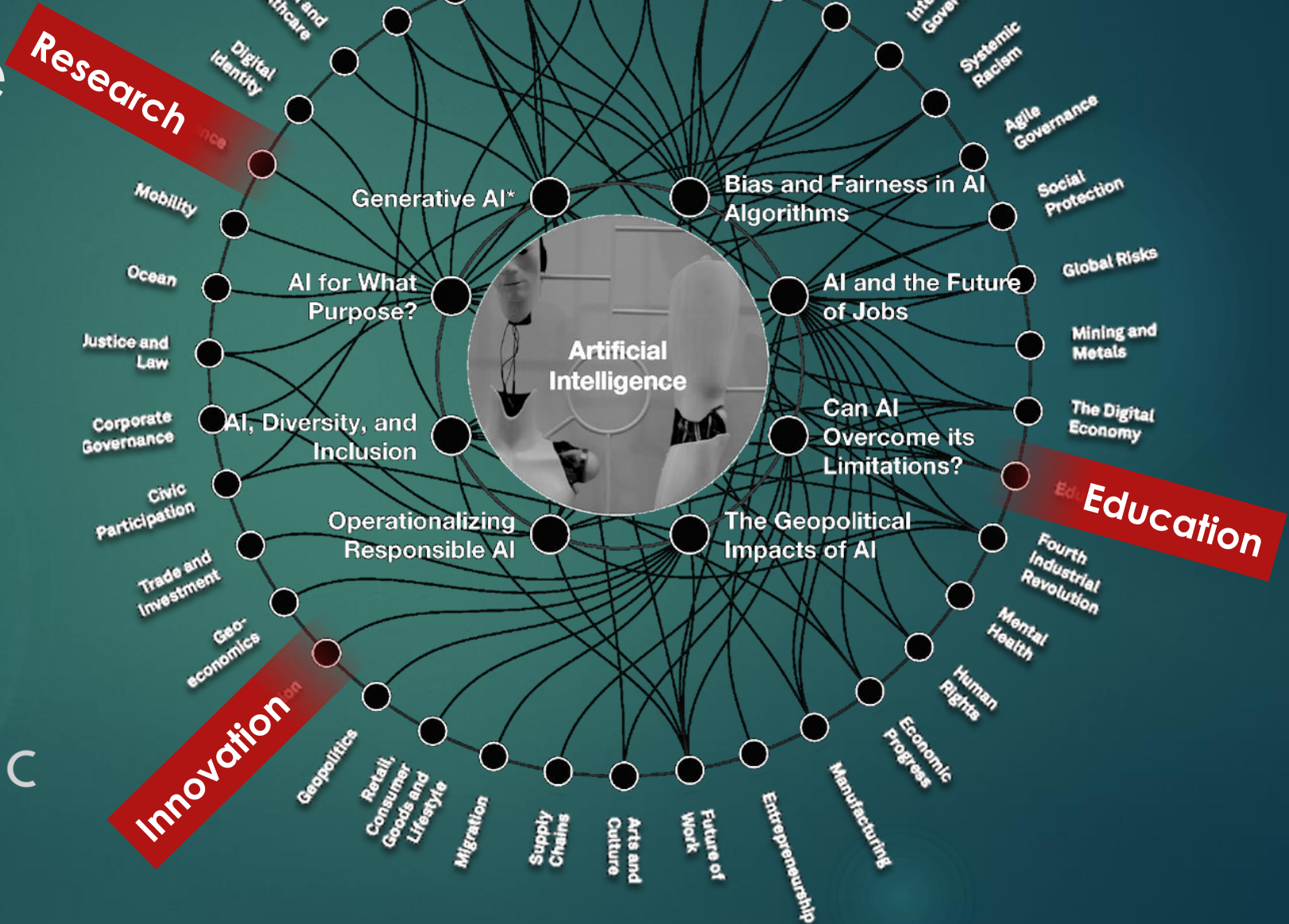


Ukraine: how
can the scientific
community help
scholars at risk?

Artificial Intelligence



WORLD
ECONOMIC
FORUM





Q: What experience
do you have with AI
in your daily life?



<https://forms.gle/JeaJMEC17LHaXGLU8>



“The vast majority of
scientific publications and
published data are useless.”

Business Unit Management,
Evonik Industries AG

The Outdated Publishing System

- Overreliance on interchangeable narrative patterns

!

>20% of article texts have 0% novel information

- Quantity-focused publishing driven by metrics

!

50% of articles have a readership of three

- Reproducibility crisis and access restrictions

!

<20% of hypotheses supported by data



Farewell to Static Print
and PDF Articles?

“Summarize in technical terms the state-of-the-art of organic semiconductor research for OLED applications.”



GPT-3, OpenAI

1	Context	<i>Organic semiconductors are a promising class of materials for organic light-emitting diode (OLED) applications due to their ability to efficiently transport charges and emit light.</i>
2	Demand – what we want & what we have	<i>Research on organic semiconductors for OLEDs is focused on developing materials with high electron and hole mobilities, efficient energy transfer from the host to the emitter, and high thermal stability. Recently, small molecule-based OLEDs have achieved high external quantum efficiencies (EQEs) of over 20% and maximum current efficiencies of over 100 cd/A. Research on polymer-based OLEDs has also made significant progress with EQEs of over 15% and maximum current efficiencies of over 80 cd/A.</i>
3	Task	<i>To further improve the performance of OLEDs, research is ongoing in areas such as developing new materials, optimizing device architectures, and improving the efficiency of the energy transfer processes.</i>
4	Subject of the document	<i>...</i>

An effective
introduction for a paper



AI in academic publishing

Chemical
Science



EDGE ARTICLE

[View Article Online](#)

[View Journal](#) | [View Issue](#)



Cite this: *Chem. Sci.*, 2023, 14, 6269

All publication charges for this article have been paid for by the Royal Society of Chemistry

On the non-bonding valence band and the electronic properties of poly(triazine imide), a graphitic carbon nitride†

David Burmeister,^{*a} Alberto Eljarrat,^b Michele Guerrini,^{bc} Eva Röck,^d Julian Plaickner,^b Christoph T. Koch,^{abe} Natalie Banerji,^d Caterina Cocchi,^{id bc} Emil J. W. List-Kratochvil^{id abe} and Michael J. Bojdys^{id *a}

Graphitic carbon nitrides are covalently-bonded, layered, and crystalline semiconductors with high thermal and oxidative stability. These properties make graphitic carbon nitrides potentially useful in overcoming the limitations of 0D molecular and 1D polymer semiconductors. In this contribution, we study structural, vibrational, electronic and transport properties of nano-crystals of poly(triazine-imide) (PTI) derivatives with intercalated Li- and Br-ions and without intercalates. Intercalation-free poly(triazine-imide) (PTI-IF) is corrugated or AB stacked and partially exfoliated. We find that the lowest energy electronic transition in PTI is forbidden due to a non-bonding uppermost valence band and that its electroluminescence

- ▶ AI-generated content for introductions and summaries
- ▶ AI tools for finding and summarizing research articles

Science and Culture of the State of Lower Saxony. N. B. and E. R. acknowledge the Swiss National Science Foundation (Grant 200020_184819) and the University of Bern for financial support. The senior lead-author generated the introduction in part with GPT-3, OpenAI's large-scale language-generation model using the prompt "Write a summary paragraph on the state of the art of organic semiconductor research". Upon generating draft language, the lead-author reviewed, edited, and revised the language to their own liking. The lead-author takes ultimate responsibility for the content of this publication.

- 21 M. J. Bojdys, N. Severin, J. P. Rabe, A. I. Cooper, A. Thomas and M. Antonietti, *Macromol. Rapid Commun.*, 2013, 34, 850–854.
- 22 G. Algara-Siller, N. Severin, S. Y. Chong, T. Björkman, R. G. Palgrave, A. Laybourn, M. Antonietti, Y. Z. Khimyak, A. V. Krashennnikov, J. P. Rabe, U. Kaiser, A. I. Cooper, A. Thomas and M. J. Bojdys, *Angew. Chem., Int. Ed.*, 2014, 53, 7450–7455.
- 23 D. Burmeister, J. Müller, J. Plaickner, Z. Kochovski, E. J. W. List-Kratochvil and M. J. Bojdys, *Chem. – Eur. J.*,



DOI: 10.1039/D3SC00667K

The Outdated Grant-Application System

- Long and bureaucratic application processes

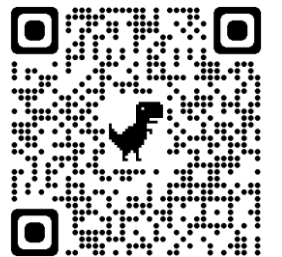
!

8-28 consulting days per grant; 6-12 months wait

- Low success rates

!

60-95% rejection rates
(up to 99%)



ChatGPT use shows that the grant-application system is broken





?

What is the point of writing
documents that can easily be
created with AI?



Proposing a New Communication Paradigm

- Decoupling from traditional metrics
- Embracing open and FAIR data principles
- Shifting towards impact-based evaluation
- Dynamic, living, and self-correcting publications



*Farewell to Static Print
and PDF Articles?*



The traditional education model
is outdated and fundamentally
unprepared for the AI age.



Shortcomings of the traditional education model

1

Passive learning

2

Outdated knowledge transfer

3

Limited test benefit

4

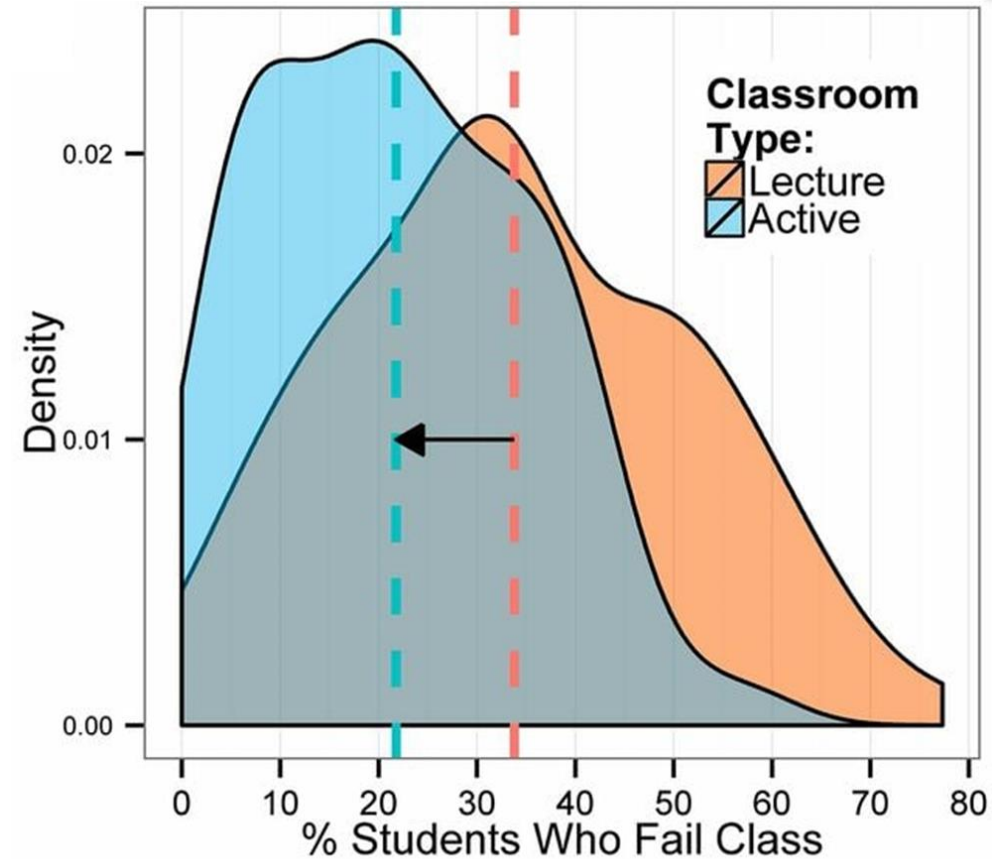
Artificial test conditions

Shortcomings of the traditional education model

1

Passive learning

- Lectures encourage passive consumption of information
- Inhibit active student participation
- Passive learning methods lead to suboptimal results

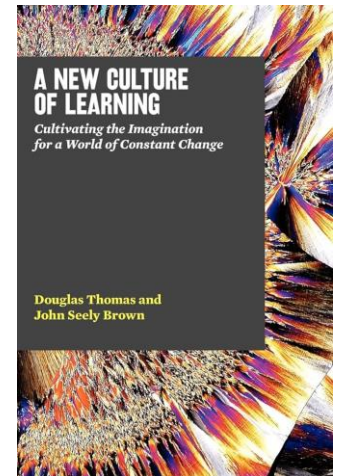
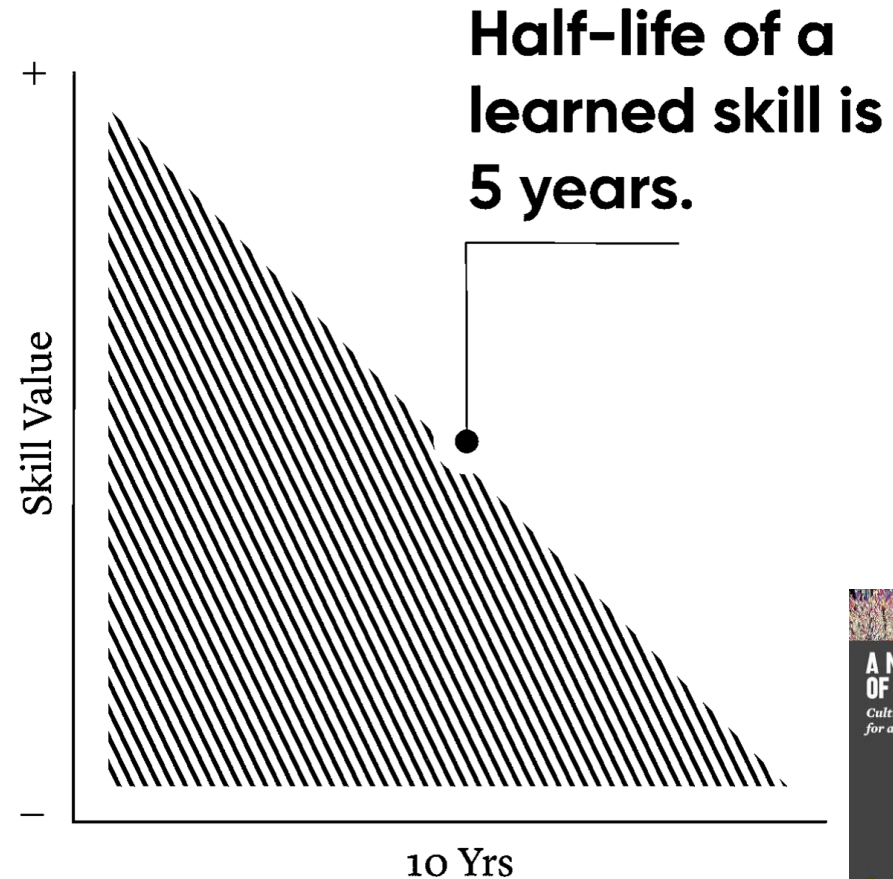


Shortcomings of the traditional education model

2

Outdated knowledge transfer

- Lectures convey outdated information
- Do not keep up with technology and industry trends
- Graduates often have skills that do not meet employer requirements



Shortcomings of the traditional education model

3

Limited test benefit

- Exams give retrospective and little action-oriented feedback
- Mainly assess memorization and recall
- Neglect practical skills for real-life situations



Shortcomings of the traditional education model

4

Artificial test conditions

- Lack of realism in problem solving and use of open resources
- Limited relevance and applicability of test results

Example project

Battery cell reverse costing

Project scope

- The client is a large European company that integrates lithium-ion battery cells into modules and systems. umlaut is consulted because the clients wants to understand the price structure of the batteries and prepare for negotiations with the supplier. The battery cells are bought from a leading Asian company with a production capacity of 24 GWh/a.
- A laboratory analysis has revealed the following information about the cell:
 1. 75 Ah pouch cell (50 cm x 10 cm x 1,2 cm) with 30 unit cell stacks
 2. Anode: 90% spherical graphite, 5% silicon, 3% carbon nanotubes, 2% SBR binder
 3. Cathode: pre-lithiated NMC-811, binder and conductive additives
- Given recent geopolitical events that caused an inflation of the battery material prices, the supplier wants to increase his sales price by 35% compared to the level of 2021.

Tasks

1. Provide an overview of a state-of-the-art battery cell production.
2. Provide a cost breakdown structure (CBS) for the battery cells bought by the client from his supplier.
3. Calculate the battery cost in \$/kWh based on the CBS.
4. Advise the client on the price increase demanded by the supplier. Is this rise in cost reasonable?
5. Considering the material price inflation - should the client try to switch to sodium-ion batteries?

Prepare a 15-minute management style presentation to showcase the results.

The rise of generative AI in education.

- AI not only highlights the shortcomings of a traditional lecture and exam model, but actively undermines its value.
- Need for lectures in doubt when AI can tailor complex information to needs in real time.
- AI provides highly personalized, instant formative feedback that grades in essays and exams cannot match.

!

If the value of a degree is simply the ability to retrieve specialized knowledge, you'll soon realize that AI tools can replicate those skills at much lower cost and with increased efficiency.

The outdated talent model

Traditional "T-shaped" talent development

- broad skills and specific expertise –
is no longer sufficient.

Technology development is faster
and

Careers are more flexible.



"I-Shaped" Expert At
One Thing



Generalist
Capable In A Lot Of Things
But Not Expert In Any



*T-Shaped
Capable In A Lot Of Things
And Expert In One Of Them

Breadth Of Experience, Knowledge & Skills



Depth Of High-Level
Expertise In One Discipline

Need for AI-resistant, "durable skills"

A new, skill-based talent model is urgently needed.

What needs to be taught is not 'what to think' but 'how to think'.



Components of a skill-based model

1

Resilient to thoughtless AI use

- Active learning methods such as debates, role plays, and discussions.
- Require active participation, creative and critical thinking.
- Authentic assignments on real-world problems.
- Collaboration with local partners to solve contemporary challenges.
- AI can provide inspiration, but should not be used thoughtlessly to solve problems.



Components of a skill-based model

2

Promotes skills that AI lacks

- AI lacks true creativity, ethical reasoning and emotional intelligence.
- Lacks the ability to collaborate, lead, and negotiate.
- Training in these skills ensures capabilities that AI does not have.
- Training in critical thinking enables effective and ethical AI use and critical outcome evaluation.



Top 10 skills – now and tomorrow



WEF
The Future of Jobs Report 2023

Top 10 skills of 2023

1.  Analytical thinking	6.  Technological literacy
2.  Creative thinking	7.  Dependability and attention to detail
3.  Resilience, flexibility and agility	8.  Empathy and active listening
4.  Motivation and self-awareness	9.  Leadership and social influence
5.  Curiosity and lifelong learning	10.  Quality control

Type of skill

 Cognitive skills  Self-efficacy  Management skills  Technology skills  Working with others

Businesses' top 10 skill priorities for 2027

1.  Analytical thinking	6.  Curiosity and lifelong learning
2.  Creative thinking	7.  Technological literacy
3.  AI and big data	8.  Design and user experience
4.  Leadership and social influence	9.  Motivation and self-awareness
5.  Resilience, flexibility and agility	10.  Empathy and active listening

Type of skill

 Cognitive skills  Self-efficacy  Technology skills  Working with others



Leveraging AI to transition to a skill-based model

1

Curriculum design and competence assignment

2

Generate content

3

Adaptive learning and feedback

4

Key performance indicators

Leveraging AI to transition to a skill-based model

1

Curriculum design and competence assignment

AI analyzes market trends and job requirements to identify skills for the curriculum and arrange them in a structured order.



Deloitte, Chemie 4.0



Leveraging AI to transition to a skill-based model

2

Generate content

AI produces creative learning exercises and ideas for real-world tasks based on current challenges.

S

Generate a list of (active learning) discussion prompts that could be in the first lesson of this course



1. How have you personally experienced AI in your daily life, and what are some examples of AI tools or applications you've encountered in educational settings?
2. Can you think of a situation in which an AI tool might be beneficial for learning? What about a situation where it might not be appropriate or effective?
3. How might AI-generated content, such as news articles or social media posts, impact the way we consume and interpret information? What are some potential risks or benefits of this reliance on AI-generated content?
4. In what ways might biases present in AI systems affect educational outcomes or perpetuate existing inequalities? How can we work to minimize these biases and ensure fair access to AI tools and resources?
5. Discuss the ethical considerations of using AI-generated content in academic settings, such as plagiarism or the potential for spreading misinformation. How can educators and students maintain academic integrity while utilizing these tools?
6. How do you envision the future of AI in education? What role do you think AI will play in shaping teaching and learning experiences, and what potential challenges or opportunities might arise?
7. Share an example of a time when you encountered a piece of AI-generated content (e.g., chatbot, news article, etc.). Were you aware that it was generated by AI? How did it affect your perception of the content's credibility or accuracy?
8. As AI continues to advance, how can we ensure that students and educators are equipped with the necessary skills to critically evaluate and make informed decisions about AI-generated content?
9. Consider the potential consequences of over-reliance on AI tools in education. What skills or abilities might be diminished, and how can we maintain a balance between leveraging AI's benefits and nurturing critical thinking and ethical decision-making?
10. In what ways can we foster a culture of continuous learning and growth in the face of rapid technological change?

Regenerate response

Leveraging AI to transition to a skill-based model

3

Adaptive learning and feedback

Real-time data enables flexible adjustments to teaching methods and automated assessment.

S

Imagine that a student submits the following answer ("I can use it to solve problems that I do not understand") to an in-class poll question ("How can you effectively use generative AI to enhance your critical and creative thinking skills"). Provide expert real-time feedback and assessment to the student, which allows the professor to quickly identify areas where the student needs additional support.



Feedback:



Your answer, "I can use it to solve problems that I do not understand," acknowledges that AI tools can assist you in problem-solving. However, it is essential to emphasize that relying solely on AI to solve problems can hinder your development of critical and creative thinking skills. To effectively use AI as a learning aid, it's crucial to strike a balance between AI assistance and active engagement with the course material.

Areas for additional support:

1. Expanding understanding of AI potential: Learn more about the various ways AI tools can be used to support and enhance critical and creative thinking skills, such as generating ideas, summarizing complex texts, or providing alternative perspectives on a topic.
2. Developing problem-solving strategies: Practice solving problems independently, using AI tools as a supplementary resource rather than a primary solution. This will allow you to develop your problem-solving abilities and apply them to various contexts.
3. Active learning techniques: Engage in active learning strategies that promote critical and creative thinking, such as group discussions, debates, and hands-on projects. This will help you to better understand complex concepts and apply them in real-world situations.

Moving forward, I encourage you to explore the potential of AI as a learning aid while also actively engaging with the course material to develop your critical and creative thinking skills. If you have any questions or need further assistance, please feel free to reach out.

Leveraging AI to transition to a skill-based model

4

Key performance indicators

AI monitors student engagement, skill acquisition, and the relationship to student success. This informs the effectiveness of the curriculum.

S

Write an email to a student taking this course who missed the previous two lessons and needs to effectively catch up on the course content by watching the class recordings, completing pre-class readings, work, and class activities.



Subject: Catching Up on Missed AI Literacy Lessons



Dear [Student Name],

I hope this email finds you well. I noticed that you were unable to attend the last two lessons in our AI Literacy course. I understand that unexpected circumstances can arise, and I want to ensure that you have the necessary resources to catch up on the course content.

To help you get up to speed, please follow these steps:

1. Watch the class recordings: You can find the video recordings of the missed lessons in our Learning Management System (LMS). Be sure to take notes on the key concepts and any questions you may have.

Lesson 1: Introduction to AI and its Applications in Education

Lesson 2: Evaluating the Use of AI Tools in Learning Environments

2. Complete pre-class readings: Please read the assigned materials in the LMS for each lesson. These readings will provide you with a deeper understanding of the topics covered in class.
3. Finish any missed work: If there were any assignments, quizzes, or activities associated with the lessons you missed, be sure to complete them as soon as possible. Submit your work through the LMS, and I will provide feedback.
4. Engage in class activities: For each lesson, there were active learning activities (e.g., think-pair-share, group discussions). While you may not be able to participate directly, try to replicate these activities on your own or with a classmate who also missed the lessons. This will help you to better internalize the course content.
5. Reach out for help: If you have any questions or concerns about the material, please do not hesitate to contact me. You can also reach out to your classmates for clarification or to discuss the topics further.

It is crucial to catch up on the missed content, as our upcoming lessons will build upon the foundations laid in these initial sessions. I am here to support you in your learning journey, and I encourage you to reach out if you need any assistance.

Principles for the use of generative AI tools in universities.

1

AI competence for students and staff

2

Support for the effective use of AI tools

3

Adapting teaching and assessment for ethical AI use

4

Maintaining academic rigor and integrity

5

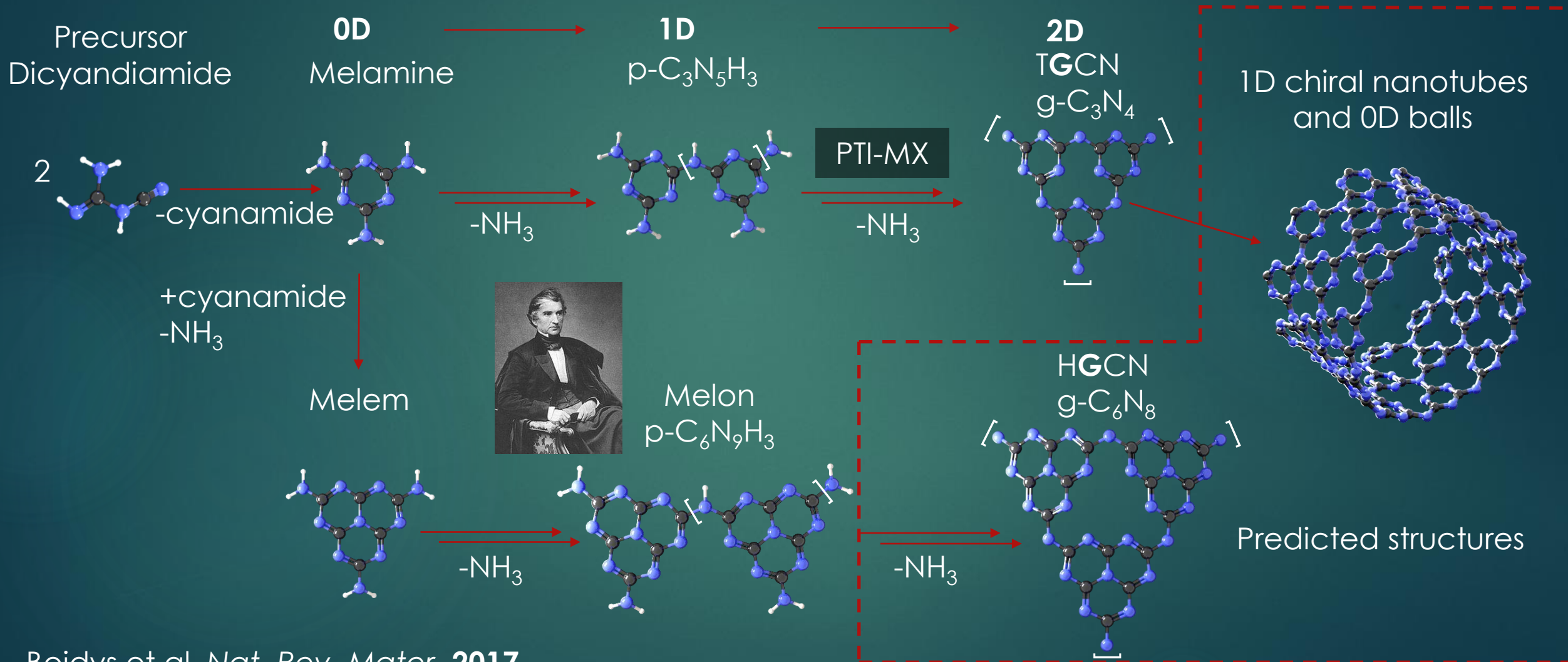
Shared learning and exchange of best practices



*Russell Group principles
on the use of generative
AI tools in education*

Example: Graphitic carbon nitride project

Carbon nitrides



Project: Market entry strategy for the sale of graphitic carbon nitride

Project Scope:

A Finnish company has developed a proprietary process for the production of graphitic carbon nitride (gCN) - based on state-of-the-art technology. The company intends to enter the market and sell to various industries. This project involves the development of a comprehensive market entry strategy to successfully launch sales of gCN.

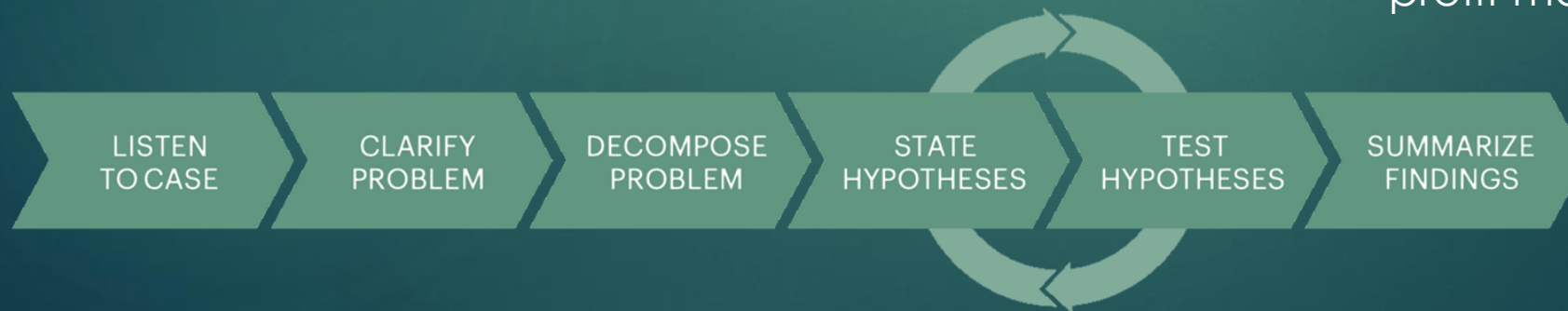
Tasks:

Market Analysis:

- Conduct an analysis of the global high performance polymers market, focusing on applications and demand for gCN.
- Identify key trends, competitors and target customer segments.

Pricing Strategy:

- Develop a pricing strategy direction that considers costs, market attractiveness, production costs, and profit margins.



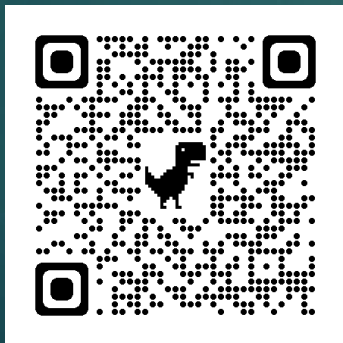
Project: Market entry strategy for the sale of graphitic carbon nitride

► <https://app.dimensions.ai/>



graphitic AND carbon AND nitride ×
Free text in full data

► <https://scholar.google.com/>



graphitic carbon nitride



Project: Market entry strategy for the sale of graphitic carbon nitride



ACS Omega **2018**, 3, 11,
15009–15017

<https://pubs.acs.org/doi/10.1021/acsomega.8b01933>



RSC Adv., **2017**, 7, 37185-37193

<https://pubs.rsc.org/en/content/articlehtml/2017/ra/c7ra05732f>



J. Am. Chem. Soc. **2017**, 139,
23, 7904–7912

<https://pubs.acs.org/doi/10.1021/jacs.7b02869>

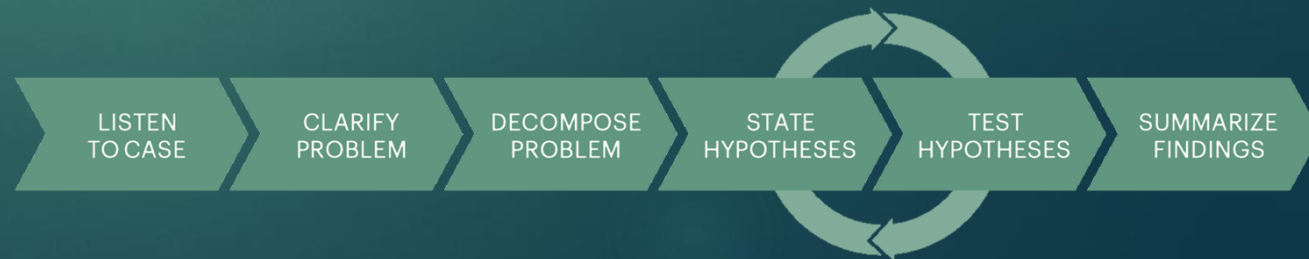
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Innovation: Materials Acceleration Platforms (MAPs)

R&D 4.0

3 GOOD HEALTH
AND WELL-BEING



7 AFFORDABLE AND
CLEAN ENERGY



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE

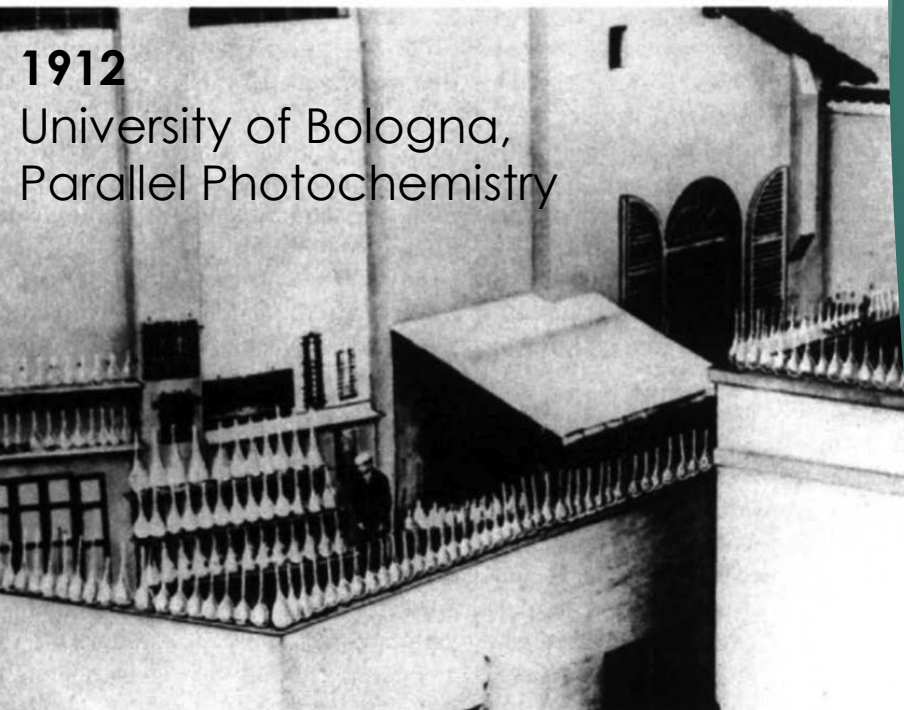


13 CLIMATE
ACTION



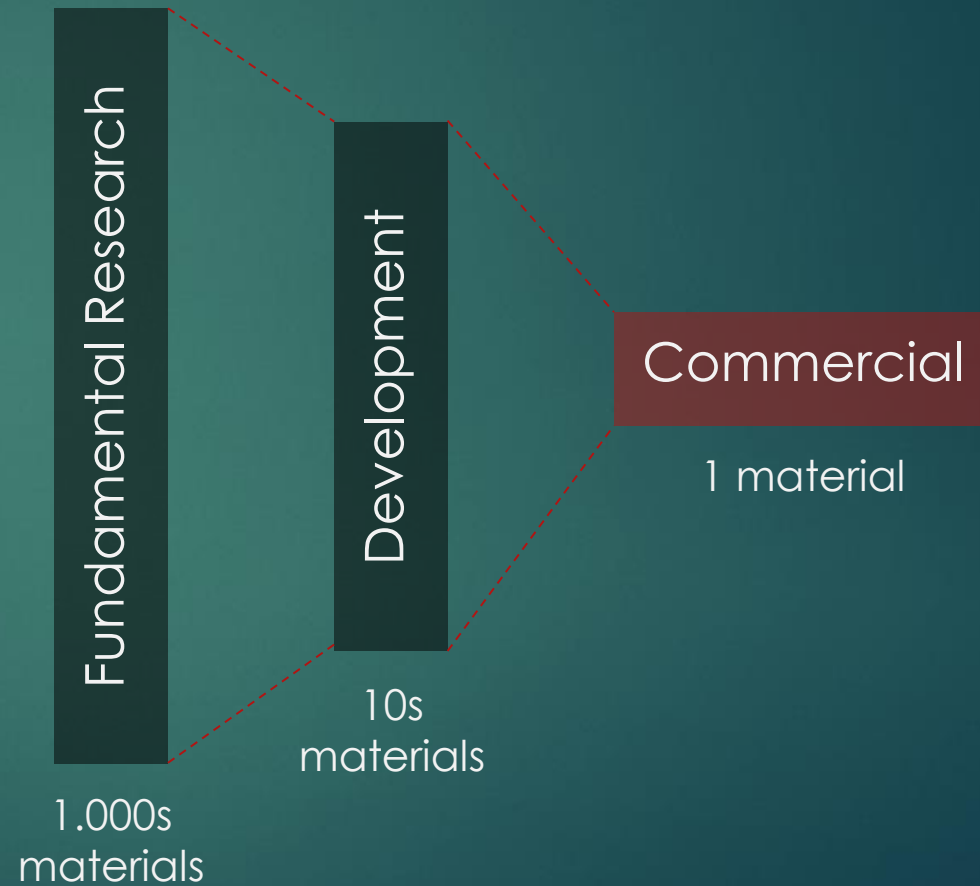


2020
Formulation robotics,
high-throughput analytics



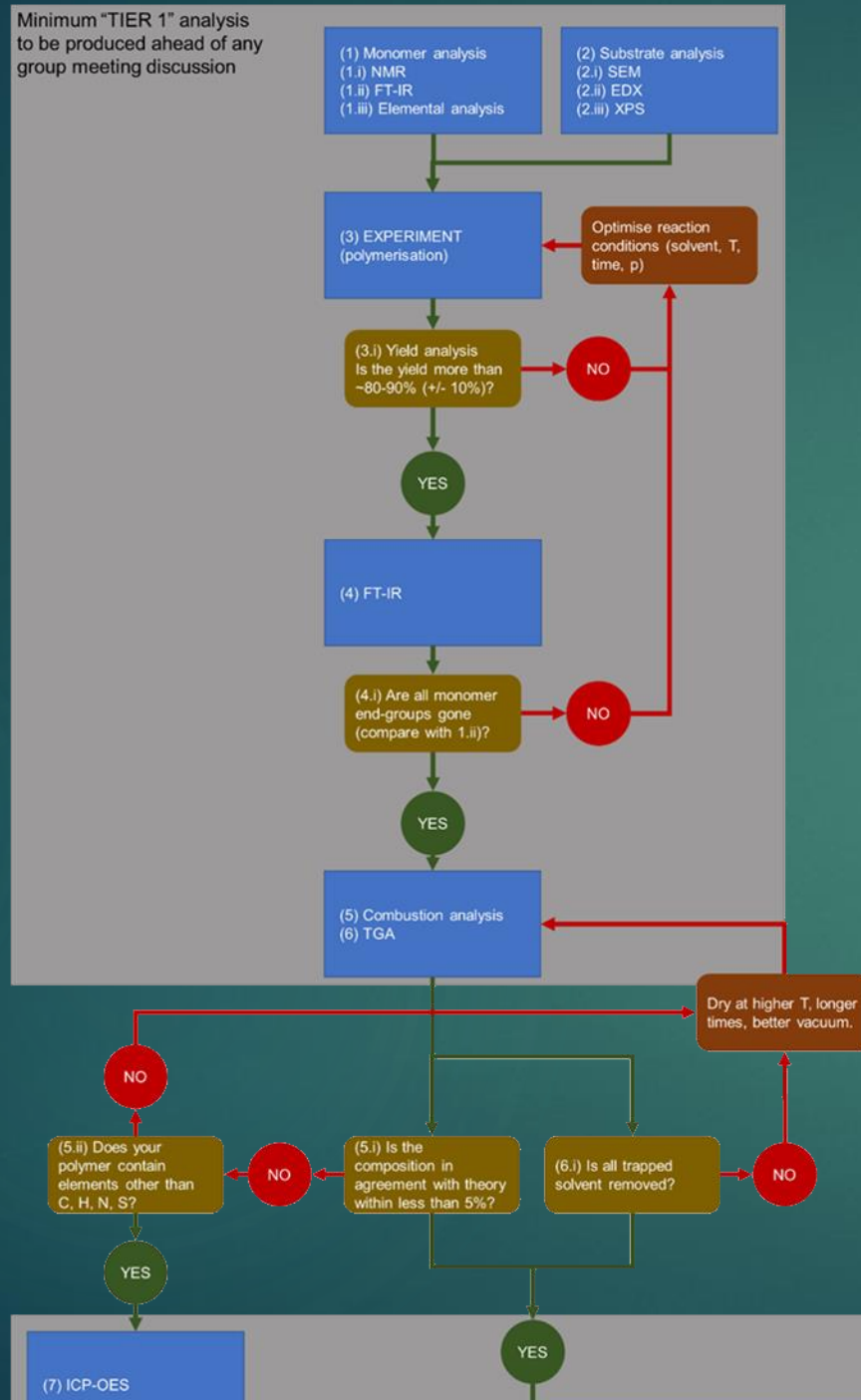
1912
University of Bologna,
Parallel Photochemistry

R&D 4.0



"Lean start-up"
approach in
materials
research

Minimum "TIER 1" analysis
to be produced ahead of any
group meeting discussion



Minimum "TIER 2" analysis
to consider a publication

Knowledge- stocks



Knowledge- streams

Patents

Publications

Raw Data

SO FAR:

Stocks of knowledge as the basis
for value creation

FUTURE:

Success through participation in
broad spectrums of "more
diverse streams of knowledge
that can renew the body of
knowledge ever more rapidly"

FAIR Data



- Findability nets Google
122400 million EUR p.a.



- Accessibility = operating
costs (598 EUR per
month for 10 TB).



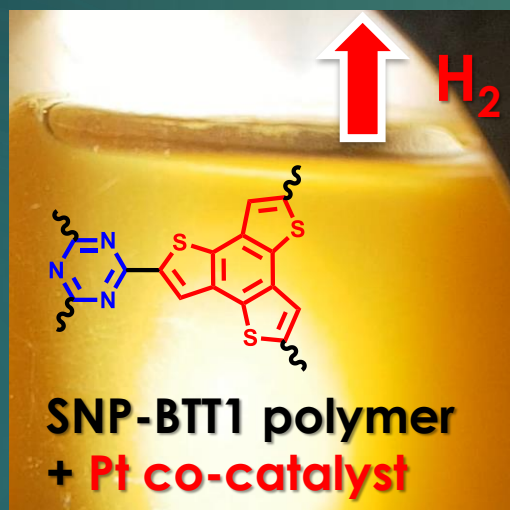
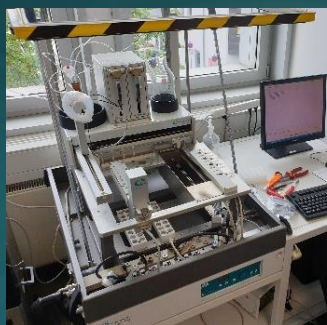
- Dealing with proprietary
instrumental data
formats?



- Status of intellectual
property and
copyrights?

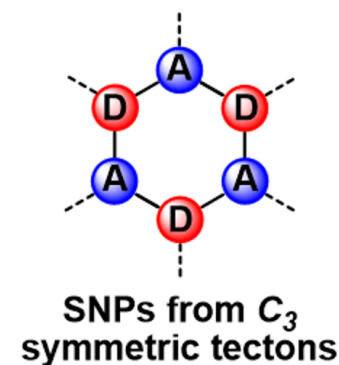
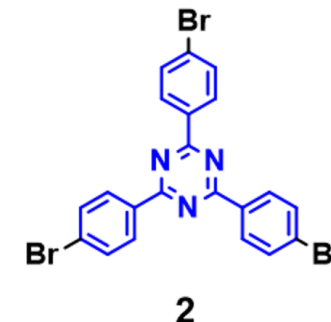
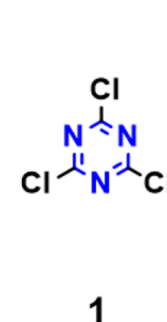
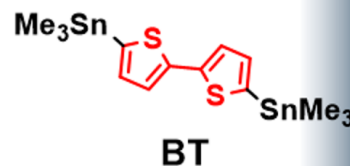
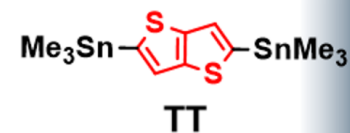
(1) Sulfur and nitrogen containing porous polymers (SNPs)

Combinatorial approach

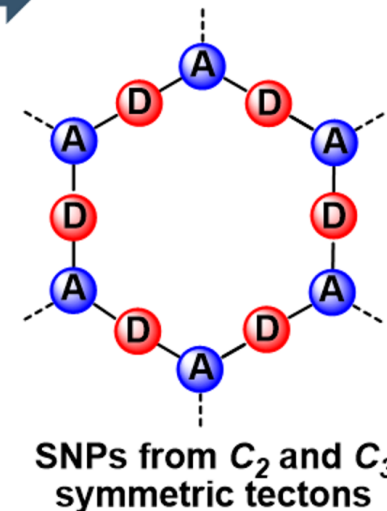
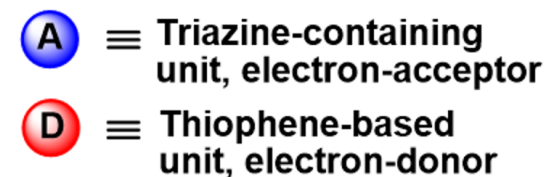


HER:
 $3158 \mu\text{mol h}^{-1}\text{g}^{-1}$

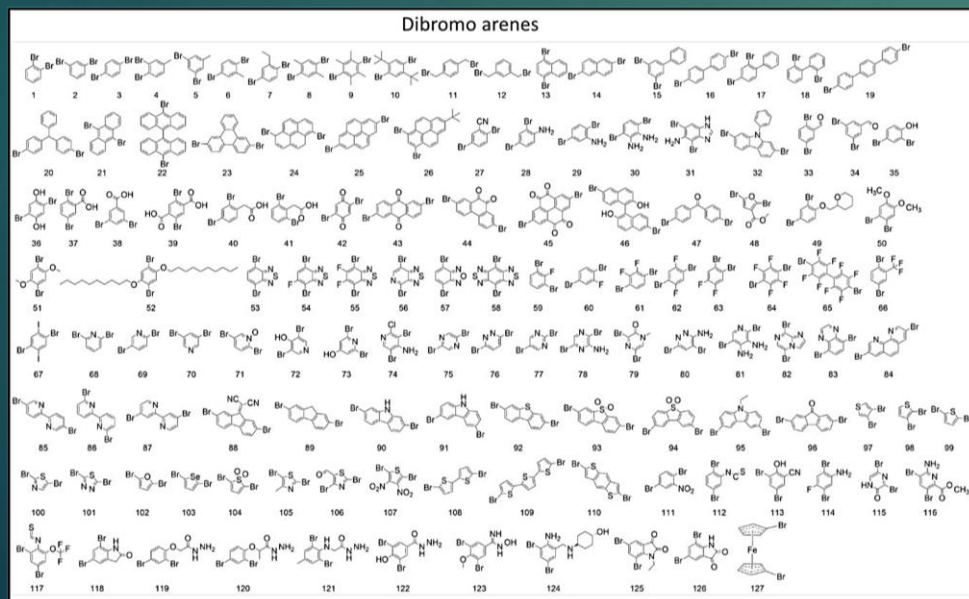
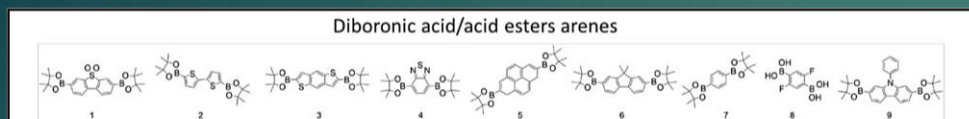
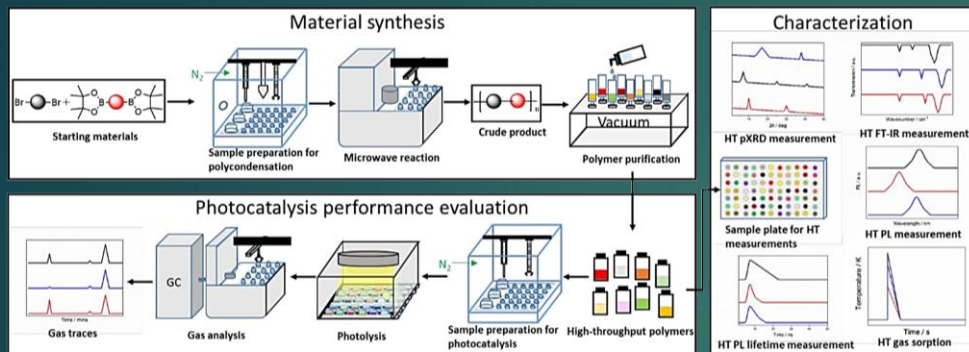
Angew. Chem. Int. Ed. **2018**,
DOI: 10.1002/anie.201809702



$\text{Pd(PPh}_3)_4$
Toluene
Reflux, Ar



(2) Conjugated microporous polymers (CMPs)

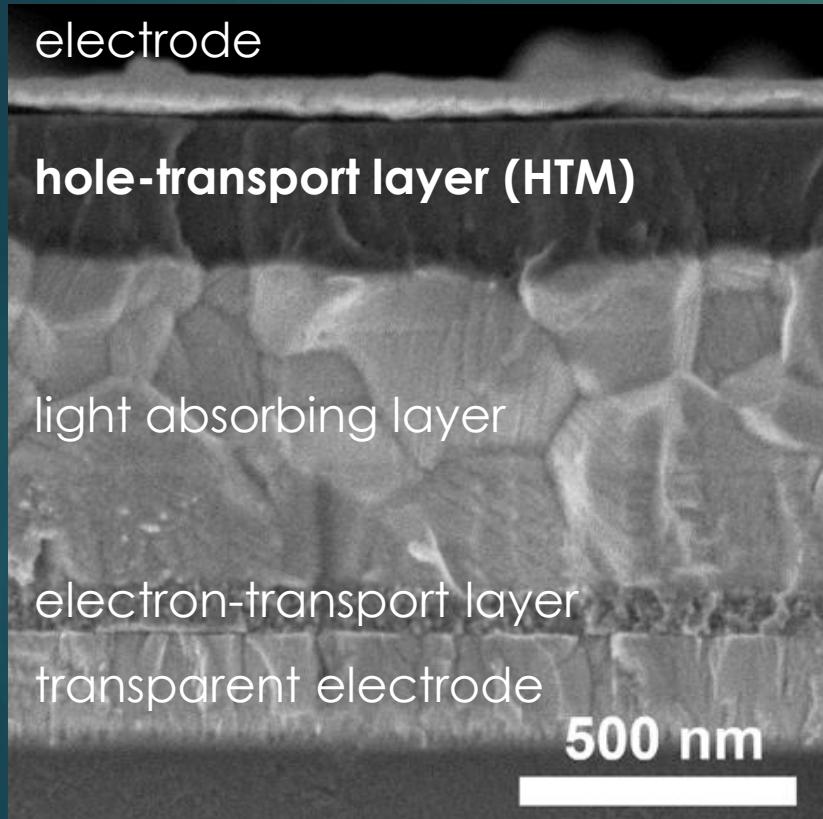


- A total of 6354 co-polymers were considered computationally
- Synthesis and characterization of a sub-library of more than 170 co-polymers.



Cooper et al. *J. Am. Chem. Soc.*,
DOI: 10.1021/jacs.9b03591

(3) Hole-transport materials films (HTM)



Molecular identity: size, shape, stiffness, redox potential

Layer processing: drying (temperature, atmosphere), annealing (time, temperature), exposure to oxygen, exposure to moisture, exposure to light.

Substrate preparation: solvent cleaning, blow-off, UV/ozone, plasma

Substrates: Glass, Quartz, FTO, Silicon

Solvents: toluene, acetonitrile, chlorobenzene

Dopants: Co^{3+} , Li^+ , Zn^{2+} , organic substances, acids, radicals

Deposition process: Spin coating, dip coating, sputtering

Additives: Plasticizers, stabilizers, surfactants



Ada: self-driving labs for accelerating materials discovery



BERLINGUETTE
RESEARCH



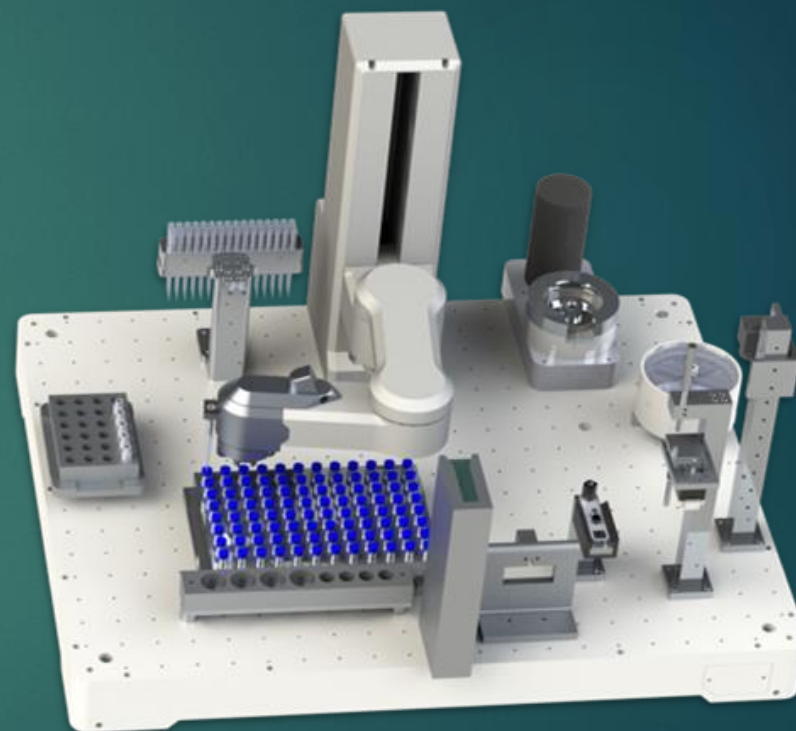
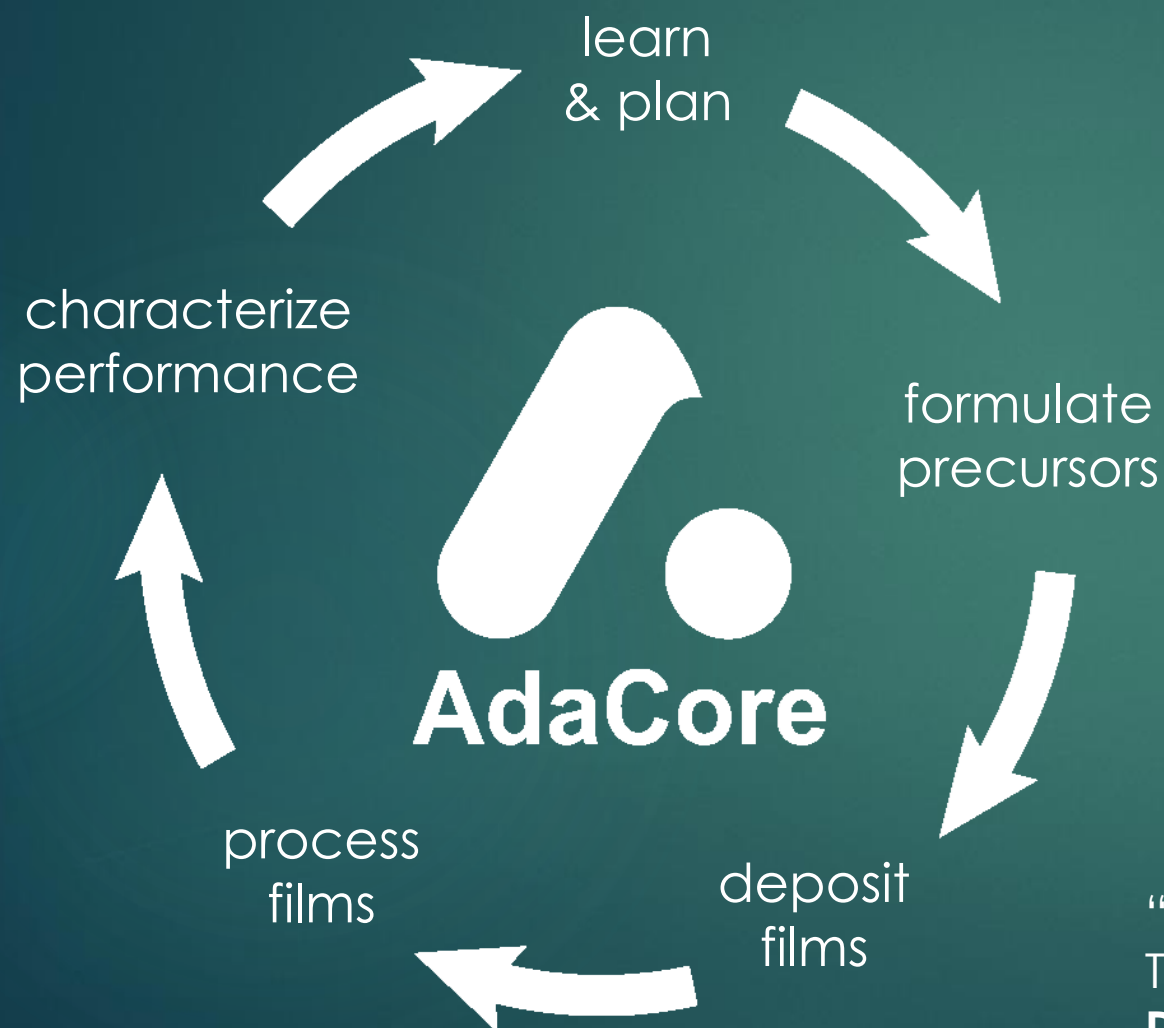
Natural Resources
Canada

Ressources naturelles
Canada

Canada

NRC-CNRC

Self-propelled laboratory for the development of hole-transport materials (HTM).



“Self-Driving Laboratory for Accelerated Discovery of Thin-Film Materials.” *Sci. Adv.* **2020**, 6 (20), eaaz8867.
DOI: 10.1126/sciadv.aaz8867

Workflows

Materials Acceleration

1: Theory and modeling
2: AI-driven design and simulations

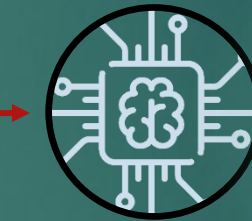
3: Autonomous robotic (MAPs)
4: Characterization and fabrication

5: AI-enabled data handling and
workflow optimization

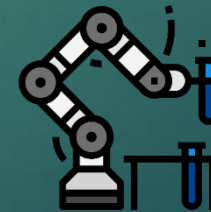
Knowledge
graphs +
data lakes



HPC



AI-prediction

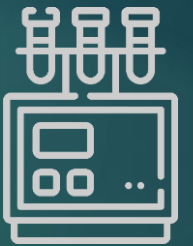


MAPs



Associated
experts

Materials
challenges



Synthesis
Fabrication
Characterization
Testing

AI & Data
Processing



High-
throughput
robotics &
analytics



R&D
focus areas

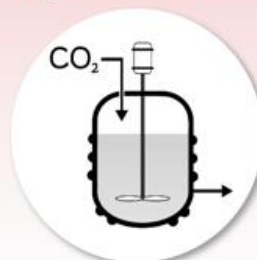
- Hydrogen production



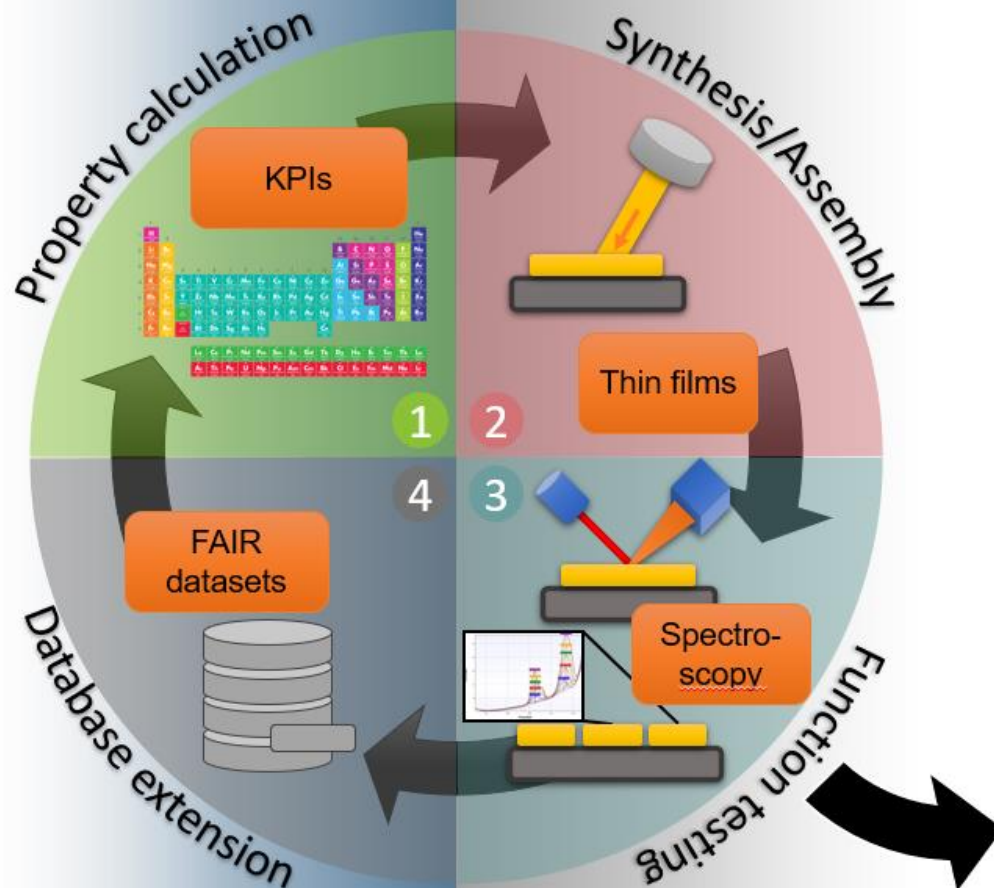
- Batteries

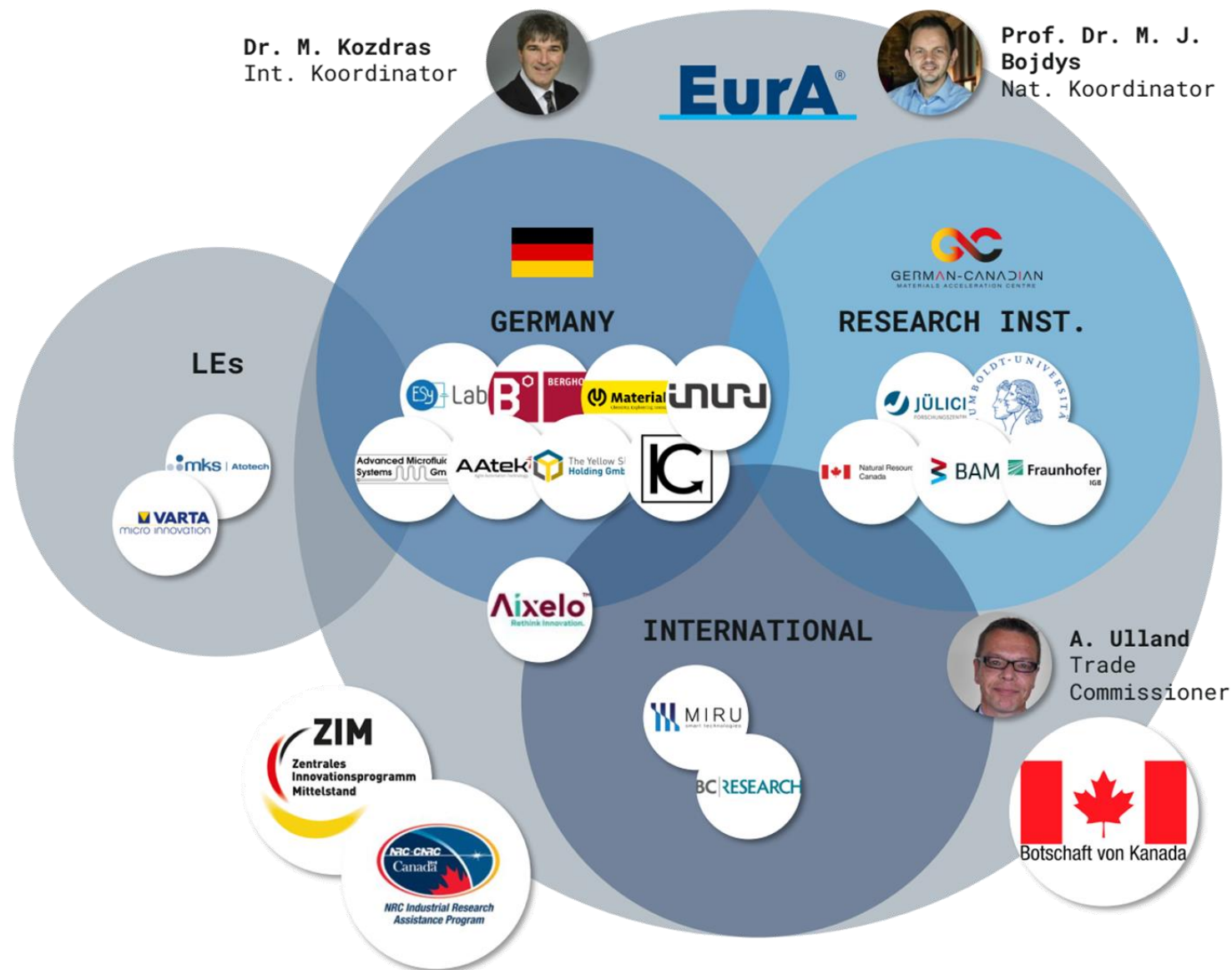


- CO₂-Reactors



Energy Materials Accelerator (EnerMAC)





Energy Materials Accelerator (EnerMAC)

No.: 16KN12401

Start: Sep 2023

Partners: 10 SMEs, 1-2 LEs, 5 RIs

Subject: Accelerated innovation for energy materials in future technologies (H₂ and CO₂ catalysis / electrolysis, batteries, AI, robotics).

ACT TOP TIPS

FROM DAY ONE
QUOTES / TESTIMONIALS
ATED DEPARTMENTAL
EFFORT
AS A PROBLEM
OR CHALLENGE
IMPACT INTO METHOD
N BUILD TEST EVALUATE
COMMUNITIES
PRACTITIONERS
WORK ↔ IMPACT
RSHIP (?)
USER"
ONES
S
ERS
/QUANT.



(Investors) are all looking for the new-new things. The thing is, the new-new things are already there. They're sitting somewhere in a file at a university, while they would better serve humanity by being licensed out, transferred to industry, or spun off into a new start-up.

Ian Soso
Managing Partner,
Monte Carlo Capital



Prof. Dr. Michael J. Bojdys

<http://bojdyslab.org/>
m.j.bojdys.02@cantab.net