2022

at a glance

Advanced
Research Center
Chemical Building
Blocks Consortium

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Chemical Building
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Foreword

2022 at a glance

At ARC CBBC, we understand that the energy transition is inextricably linked to the feedstock and materials transitions. The switch to the use of different feedstocks and raw materials for our products and the redesign of materials with entirely new properties demands a multidisciplinary approach. In light of this, ARC CBCC is investigating new methods for the chemical recycling of plastics, the development of coatings produced partially on the basis of waste flows, and the use of CO_2 as a feedstock. Only through close collaboration within the scientific community, in conjunction with society and industry, can these three transitions be achieved, albeit one step at a time.

The opening of the ARC CBBC hub lab in Groningen and the accompanying symposium ensured that 2022 was off to a good start. Talented scientists now have even more opportunities to contribute to the greenification of the chemistry industry and a more sustainable society. 2022 saw the launch of our latest multilateral project, New Chemistries, which has given seventeen aspiring researchers a wonderful opportunity to further develop their talents. We are looking forward to the results produced by this group of talented individuals!

We also bade farewell to the first cohort of six ARC CBBC PhD graduates in 2022. After four years of research at ARC CBBC, they can now proudly call themselves Doctor of Science. We hope these talented young people can make an active contribution to the greenification of the chemical industry. Several of them and their co-researchers are featured in a number of articles in this Annual Report. These talented individuals are our future; they are the connectors of tomorrow. Of course, we must not forget our ARC CBBC alumni. Further on in this Annual Report, you can read all about what they are currently doing.

So, it is with great pride that I present you the ARC CBBC 2022 Annual Report.

Prof. Dr. ir. Bert Weckhuysen

Director of Science of ARC CBBC

Timeline 2022

25/26 January
Physics@ Veldhoven

4 February
Visit Hatte van der Woude

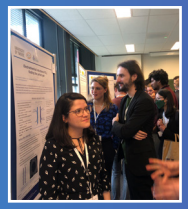
16 February
Pitch Training

7 March
Infographics Skills Course

10 March
Presentation Skills Course

16 March
Online lecture by Moniek Tromp

13 April
Lab opening & symposium



12 April
Community Event

14 April
Annual SAB meeting

9/10/11 May
N3C

18 May
Online lecture by Matthias Bickelhaupt

13/14/15 June
Summer School

27 June
Bilateral meeting at Shell

27 June
iLinqs Festival van de Industrie

7 September
Visit KNCV hub Utrecht

15/16 September
Catalysis Connected

21/22 September
NWO CHAINS

1/2 October
Weekend van de Wetenschap

6 October
Utrecht Science Week

17 October
Attention and Concentration Skills Course

29/30 November
EIES22

Opening of the University of Groningen lab & Symposium

Left: Moderator Joost Hoebink and rector magnificus Cisca Wijmenga of the University of Groningen at opening Symposium
Below: Live stream Ben Feringa & Jacqueline Vaessen opening the new ARC CBBC laboratorium

This year's uncontested highlight was the opening of the new ARC CBBC hub lab at the University of Groningen, which took place during our symposium. Not only was this an inspiring event, but it also marked a new step in our unique hub infrastructure.

The opening of the hub lab in Groningen was streamed live at the symposium. Programme Director Prof. Ben Feringa and Chair of ChemistryNL Jacqueline Vaessen unveiled an acacia tree in front of the Linnaeusborg Building to commemorate the opening of the lab. Through the opening of this new lab, all hub universities have invested in their hub labs and the accompanying equipment for ARC CBBC. The hub lab in Groningen is a valuable addition to the ARC CBBC lab infrastructure. The University of Groningen focuses on homogeneous catalysis, organic synthesis, materials and coatings and contributes to the foundation for the collective and multidisciplinary research performed at ARC CBBC.

To complete the transition to a circular chemical industry, we – as ARC CBBC – will need to embrace multidisciplinary thinking. Our symposium therefore shone a light not only on the chemical industry, but also examined perspectives offered by other disciplines on the transition to a sustainable society. The symposium concluded with a panel discussion featuring Prof. Klaus Hubacek and Prof. Linda Steg, co-authors of the IPCC Report, who contributed to the debate from their respective backgrounds in the fields of sociology and environmental psychology. In addition to the above, the event featured showcase presentations by our PhD candidates as well as high-speed lectures by our tenure track assistant professors, panel discussions with our programme directors and lab interviews from the hub lab in Groningen.

- Ben Feringa & Jacqueline Vaessen ▼ open the new ARC CBBC hub lab in Groningen.
- Interview with Hung Chien Lin at the lab during symposium
- Report on the ARC CBBC symposium

Sarina Maßmann

When the subject of the feedstock transition comes up, it never takes long before the name of Sarina Maßmann of the University of Groningen is mentioned. She is conducting research into plastic coatings based on biomass rather than oil.

Even more specific: Sarina Maßmann is investigating the production of coatings based on organic raw materials, such as waste from the manufacturing industry, in water-based solvents. This way, she is not only looking into ways to reduce our dependency on fossil fuels, but also how we can apply coatings produced from natural substances without the addition of solvents, which are often toxic. The blog published by Sarina, which can be found below, offers an outstanding explanation of her research. At the ARC CBBC symposium in April 2022, she was awarded the prize for best pitch presentation for her excellent talk.

Sarina is engaged in the Coatings multilateral project, in which companies in the chemical industry such as AkzoNobel and BASF are also involved. This multilateral approach facilitates the alignment of her research with its envisioned applications in the future. In addition she is currently cooperating with researchers from the University of Amsterdam, Utrecht University, Eindhoven University of Technology and the University of Twente to facilitate the optimum sharing and exchange of ideas, questions and perspectives.

- Pitch Sarina Maßmann
- Blog Sarina Maßmann

Sobhan Neyrizi

"With the novel molecules designed in our research, we could innovate a new pathway for CO_2 conversion."

Carbon monoxide (or CO) is known, above all, as a toxic gas that is released during the incomplete combustion of a substance such as gas. Many of us have installed carbon monoxide detectors in our homes, which warn us of the presence of CO. But did you know that CO is actually a highly useful substance in the chemical industry? This is because it is an intermediate product that can be used to produce various chemical building blocks.

PhD candidate Sobhan Neyrizi of the University of Twente is conducting a study into the efficient conversion of CO_2 into CO. There are different methods to convert CO_2 into CO, but Sobhan specifically researches electrochemical conversion: the use of electricity to transform one substance into another. This method is currently receiving a great deal of attention, as many branches of industry are looking for methods to facilitate the electrification of their processes. Conventional processes often depend on high temperatures, which are difficult to achieve without the use of fossil fuels. A switch to production processes that are powered by electrical energy sources is therefore highly desirable. At ARC CBBC we have acknowledged the potentia of electrochemistry from the start, the project of Sobhan being an example of this. However, one of the stumbling blocks in these processes is, as is often the case, the efficiency. Despite everything we know today, too much energy is still being lost.

Sobhan's research focuses on optimizing the efficiency of the process in which CO_2 is converted to CO. Specifically, he is examining the influence of certain parameters within the set-ups he is using, such as molecules present during the reaction that could facilitate the progress of the reaction. Eventually, the ultimate goal is to convert CO_2 into CO, using sustainable electricity, and to subsequently apply this in the manufacture of sustainable products in the future.

- Eye opener Sobhan Neyrizi
- News item publication Sobhan Neyrizi

Our story

Greenifying chemistry to accelerate the transition towards a circular, waste-free society: this, in a nutshell, is what drives ARC CBBC. Within ARC CBBC, academia and industry join forces to curb fragmentation in the field of green chemistry and collaborate to deliver solutions for the carbon and energy-efficient economy of the future.

MP Hatte van der Woude ▲ at the ARC CBBC hub lab in Utrecht.

Circular chemistry is a topic that we encounter increasingly often and in more and more areas in our everyday lives. The electrification of cars is already in full swing, and more and more people are endeavouring to separate their household waste as effectively as possible to prepare it for recycling. It is of crucial importance that ARC CBBC's mission engenders support not only within scientific circles, but also from the world at large.

To accelerate the sustainability of the chemical industry, much more is needed than chemical research alone. Political involvement is equally important. On 4 February, Hatte van der Woude, spokesperson for higher education, science policy, teacher policy and emancipation for the VVD (People's Party for Freedom and Democracy) in the Dutch House of Representatives, visited our hub lab in Utrecht. In a discussion with Anton Pijpers (President of the Utrecht University Executive Board) and Bert Weckhuysen (Scientific Director of ARC CBBC), she examined the value of fundamental research for social issues and the interaction between this and applied science. Other topics of discussion were knowledge security, internationalization, multidisciplinary cooperation, excellence, and knowledge and appreciation.

Reinventing chemistry

In order to further embed circular chemistry into our everyday society, we will need to develop new

manufacturing routes for many of the necessities we use each and every day: from fuels to pharmaceuticals, coatings and plastics. This includes the use of new feedstocks and the design of innovative products and production processes.

One of the PhD candidates to have defended their thesis successfully in 2022 was Sanjana Chandrashekar. Chandrashekar conducted research into the conversion of CO_2 into sustainable fuel: a prime example of transforming a waste product into a feedstock. She made significant progress in her research on the electrochemical conversion of CO_2. The influence of certain elements in the set-up of this process was one of the topics extensively clarified in her research, which brings the scaling up of this process yet another step closer towards its completion.

New multilateral project

ARC CBBC tackles the challenges of 'greenifying chemistry' through multilateral and bilateral programmes based on three themes: the materials transition, the feedstock transition and the energy transition. In multilateral projects, multiple industrial partners are involved, while in bilateral projects one of our industrial partners teams up with academic partners.

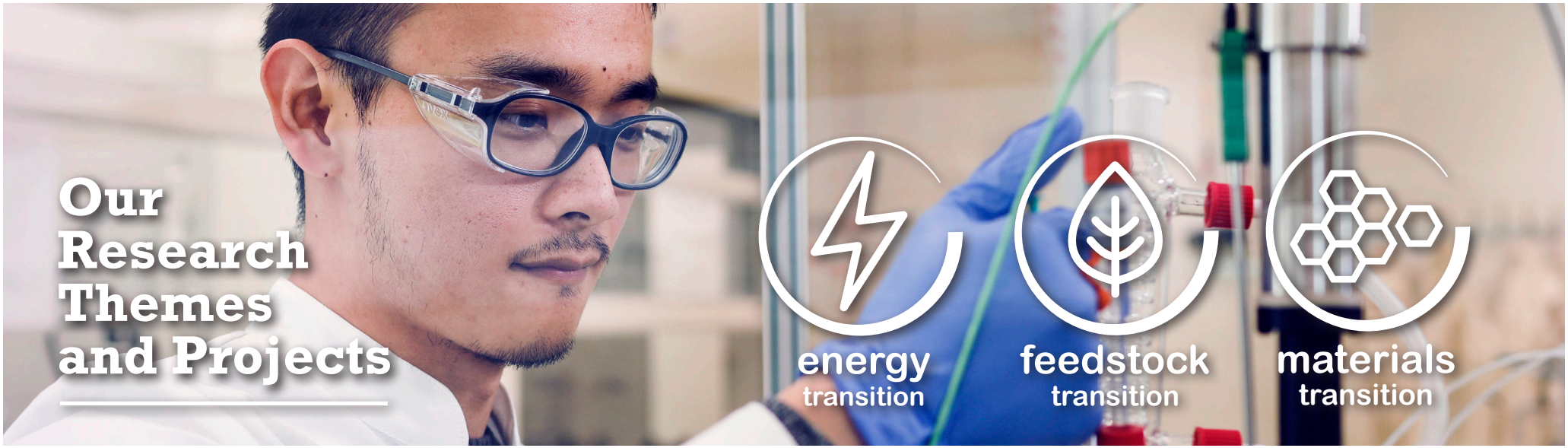
In 2022, significant steps were taken within the framework of our fourth and most recently launched multilateral project, New Chemistries. Fourteen new researchers have since started working on this project, in which nineteen researchers were involved in 2022. The synergy between the various partners, who stem from both the academic world and the chemical industry, ensures an ideal climate for the discovery of new, innovative products and processes.

Sanjana Chandrashekar (TUD):
"Working with you at ARC CBBC has been a pleasure, just like seeing how the consortium has grown in the past years. ARC CBBC is unique in its commitment to the development of its researchers. It was wonderful to have been part of such an amazing community. I have enjoyed my time here."

rtlz

RTLZ: Doe Maar Duurzaam

In a documentary for the Dutch television series Doe Maar Duurzaam (informal translation: 'Let's go for sustainable') by TV broadcaster RTLZ, our Scientific Director Bert Weckhuysen sheds further light on the goals of ARC CBBC.



At ARC CBBC, we focus on three principal research themes that we examine in connection with one another: the energy transition, the feedstock transition and the materials transition. We achieved substantial progress in our projects in 2022. We would like to shine a spotlight on several of these below. Please refer to our renewed website for a comprehensive overview of our research projects.

1. The Energy Transition

The transition to an energy-efficient chemical industry pleads urgently for the development of safe and renewable energy carriers and new low-energy methods for the production of chemicals. ARC CBBC is exploring the development of such energy carriers, as well as new methods of chemical conversion that make use of renewable energy sources.

Sustainable fuel derived from CO_2 can be one of these suitable energy carriers. Surplus sustainable electricity, generated when there is a lot of sun or wind, can be used to make these fuels. This sustainable energy can then be stored for future use. This is also an example of how the energy transition is linked to the feedstock transition: a waste product (CO_2) is used as a feedstock (fuel). Francesco Mattarozzi (Utrecht University) is conducting research into recycling CO_2. Mattarozzi, and on behalf of ARC CBBC, was one of the speakers at the European Industry and Energy Summit in Geleen.

- Renewed website ARC CBBC
- Francesco Mattarozzi ▼ at the European Industry and Energy Summit in Geleen. He previously posted an Eye Opener (a one-minute vlog) about his research.

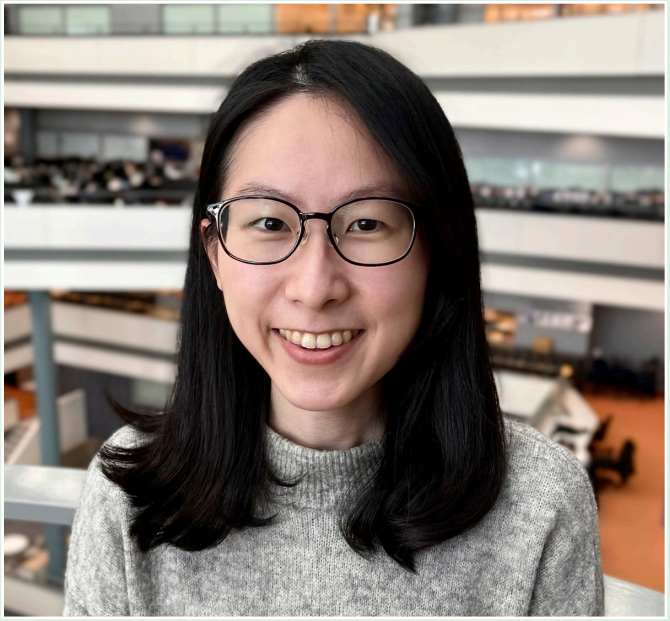
2. The Feedstock Transition

To achieve full circularity in the production of everyday products and materials, the use of biomass and waste flows as feedstocks for chemical production is of crucial importance. This is why the development of highly efficient catalytic technologies is indispensable. They will facilitate these challenging transformations and additionally the processing of these new types of raw materials on a large scale and in the most energy-efficient way possible. At ARC CBBC, we are developing new chemical concepts to accelerate the transition towards a more sustainable use and new types of feedstocks.

For example we investigate if it is possible to break plastics down into their original building blocks again. And if we reuse these chemical building blocks as feedstock for products, such as plastic bottles.

In 2022, our multilateral project New Chemistries took on a more concrete shape. One of the pillars within this project focuses on plastics – more specifically: the chemical recycling of plastics, in which plastic waste can be reused as a feedstock. This could mean a new step within the feedstock transition. PhD candidate En Chen is one of the researchers studying this topic at Utrecht University. She is examining the possibility of using UV light to break plastics down into their chemical building blocks.

PhD candidate En Chen ▶ (Utrecht University) was interviewed about her research on the recycling of plastics for the European Industry and Energy Summit.



PhD candidates ▲ Felix de Zwart and Nicole van Leeuwen (both UvA) have discovered a new, more sustainable production method for polyurea, a material frequently used to produce coatings.

3. The Materials Transition

The sustainable production of future materials is key to the greenification of the chemical industry and society at large. ARC CBBC is working on the development of new materials that are produced from renewable resources and have innovative properties. One of the questions we are trying to answer is: can we design products to last as long as possible? And can we ensure that they are recycled more easily should they need to be replaced?

An example of a product that is particularly well suited for the materials transition is coatings. Is there anything we can do to make them last longer, and can we use them for other purposes? One of our first multilateral projects, Coatings, approached completion in 2022. Sarina Maßmann, for example, has almost completed her PhD studies at the University of Groningen. You can read more about her and her work on page 6. In 2023, a spin-off of our Coatings project will be launched: the multilateral Smart Coatings project.

Another key topic within the materials transition is catalysts. By making more effective use of catalysts, reactions that are more difficult to achieve by nature can be facilitated more easily. PhD candidate Sophie van Vreeswijk conducted research into improving the performance and efficiency of catalysts. You will find more detailed information about Sophie van Vreeswijk and her research on page 19.

Marie Brands

Hydrogen is sometimes considered to be the 'crown prince of fuels'. You can make green hydrogen from water, and when it is combusted it simply turns back into water – a process in which, ideally, no CO_2 is emitted. The easiest way to carry out this conversion is by using platinum as a catalyst. Unfortunately, platinum is a very rare metal. This prompted Marie Brands of the University of Amsterdam search for an alternative to platinum for the conversion of water into hydrogen.

When green hydrogen is produced, water is converted into hydrogen with the aid of electricity and sunlight. Platinum acts as a catalyst in this process. Marie is investigating the possibility of using catalysts other than platinum for this, such as iron and cobalt, since these metals are not as rare as platinum. Marie's showcase at the ARC CBBC Symposium in April 2022 displayed her vision of the future based on the research she is conducting. Imagine that you generate energy using solar panels during the day and subsequently use any left-over electricity to convert water into hydrogen. When it grows dark at night and your solar panels generate less energy – precisely at that point in time when you need electricity to illuminate your home – you can use your home-converted hydrogen to satisfy your night-time electricity demand. This process therefore allows you to store any excess energy generated during the day for use in the evening, when you need it most. At ARC CBBC, Marie is currently investigating what is needed for her vision to become a reality.

Chuncheng Liu

What do nylon, aspirin and insulation material have in common? They can all be made from aromatics: a family of chemical building blocks. Just like many chemical building blocks, aromatics are generally derived from fossil feedstocks such as petroleum. Would it be possible to find an alternative that allows us to produce aromatics from other, sustainable sources and, by doing so, make us less dependent on fossil feedstocks? These are the questions Chuncheng Liu of Delft University of Technology is trying to answer in his research.

The use of carbon dioxide (CO_2) as a feedstock is a hot topic at ARC CBBC. Using CO_2 as a feedstock would not only result in the extraction of CO_2 from the atmosphere; it would also facilitate the replacement of fossil feed-stocks in production processes. As such, methanol can be produced from CO_2 and green hydrogen (H_2). Subsequently, the research carried out by Chuncheng examines the possibility of using this methanol to produce aromatics.

By substituting the fossil feedstocks used for the production of nylon, aspirin and insulation material with methanol – and indirectly CO_2 – the chemical industry will continue to make progress towards greener production methods. The use of methanol produced from CO_2 as feedstock has multiple advantages: the problems resulting from the use of fossil feedstocks are avoided, and the methanol production process inherently ensures that CO_2 is captured from the atmosphere. This study is certainly quite an achievement towards the realization of the feedstock transition!

In 2022, Chuncheng Liu successfully defended his thesis 'The Hydrocarbon-pool Chemistry of Methanol Conversions in Zeolite Catalysts'.

Communication

Knowing that a sustainable and circular manufacturing industry is of tremendous importance to society, we are aware of our responsibility to connect with a broad public. In order to establish a connection between industry and politics, as well as with interested outsiders, we are making continuous investments in the explanation and visibility of our scientific research.

Our researchers were present at four external events in 2022. Aside from our social media activities, more than 450 interested parties subscribed to our newsletters in 2022, and we regularly posted news items on our website and social media channels. ARC CBBC's following has risen by 20% on Twitter and by almost 50% on LinkedIn.

iLinqs Festival

In addition to our own event, which took place in April and about which you can read more on page 5, we were also present at the iLinqs Festival of the Manufacturing Industry in Rotterdam and the Utrecht Science Week. Our website was fully renewed and expanded with a special page (Chemistry from the lab to the people) to provide even more space for explaining our scientific research to a broader public.

▲ Shrinjay Sharma and Rens Kamphorst (both TUD) represented ARC CBBC at the iLinqs Festival of the Manufacturing Industry in Rotterdam. They presented their research to an audience from various branches of industry.

Utrecht Science Week

Sustainability was one of the main topics of the Utrecht Science Week, an event organized at and by the Utrecht Science Park at Utrecht University. In the pleasant festival-like atmosphere of the Botanical Gardens, Science Director Bert Weckhuysen presented a lunchtime lecture on the circular economy and the refinery of the future. This was followed by three high-speed lectures presented by tenure track assistant professors Ina Vollmer, Matteo Monai and Eline Hutter, respectively, to a mixed audience consisting of academics from ARC CBBC and beyond, as well as other interested persons.

Podcast by Morteza Hadian

ARC CBBC published its first podcast in 2022. Host Morteza Hadian (TU/e) was joined by guests from the studio with a background in industry and academia in exploring the role played by methane today, in the past and in the future. The podcast can be accessed on Spotify, Google Podcasts, Apple Podcasts and via our website.

European Industry and Energy Summit (EIES) 2022

ARC CBBC was invited to organize an industry-oriented side event at the European Industry and Energy Summit held on the Chemelot Brightlands Campus in Geleen. Various researchers affiliated with ARC CBBC and representatives from the manufacturing and chemical industries presented brief lectures and participated in panels. Dirk Smit (Shell) spoke during the plenary opening session about scaling up, the energy of the future, and possibilities for storing this. After his brief lecture, Programme Director Hans Kuipers presented an Energizing Talk for the industry representatives present at the event.

Catalysis Connected

During the 2022 edition of the Catalysis Connected conference, aspiring researchers in the field of catalysis were invited to share their perspective and research on the use of waste products as feedstock. They were joined by quite a few ARC CBBC researchers, which presented them with an opportunity to connect with other researchers from Belgium and the Netherlands. The researchers attending the conference came from various universities and were active in a diversity disciplines, such as biology and waste flow management.

Top left: Ina Vollmer giving a lecture at the Utrecht Science Week
Top right: Morteza Hadian Podcast
Below: Hans Kuipers presenting an Energizing Talk at EIES 2022

Education

We attach great importance to how we educate – and thus equip – our young researchers. In addition to lectures, such as the online lectures presented by Prof. Matthias Bickelhaupt and Prof. Moniek Tromp in 2022, we provide these young talented people with multiple learning opportunities.

The sharing of knowledge and expertise happens naturally thanks to the inherent set-up of our multilateral programmes. However, it is also expressly facilitated by events such as bilateral meetings held on our partners' premises. A perfect example of this is the one we organized at Shell in 2022. All the students involved in the bilateral projects with Shell met at the Energy Transition Campus Amsterdam (ETCA) on 27 June. Here, they were given a unique opportunity not only to interact with each other but also to gain important knowledge from the Shell research staff. They were able to present their work to each other as well as various attendees from Shell, and were also shown around the ETCA research facilities to get a taste of what it would be like to work in the field of chemistry on a scale as large as this.

Top: Kitty Nijmeijer at the ARC CBBC Summer School
Right: Meeting Shell at the Energy Transition Campus Amsterdam (ETCA)

Summer School

A prime example of how we encourage the exchange of knowledge and expertise is our summer school. In summer of 2022, after two online editions, we finally got the chance to meet each other in person. We visited AkzoNobel, where experts from this multinational company, including alumnus Lukas Wolzak, offered our students an extensive and interesting programme. This included presentations highlighting various R&D activities, a tour of the research facilities, and a case study to consider: what does it take for a company like AkzoNobel to think sustainably? In addition, ARC CBBC's excellent scientists Monique van der Veen, Kitty Nijmeijer, Hans Kuipers and Evren Ünsal presented some very interesting lectures. The intensive and also entertaining summer school programme held at beautiful Kasteel Oud Poelgeest and featuring lectures and interactive sessions such as 'PhD teaches PhD' was concluded with a lovely boat trip through the canals of Leiden.

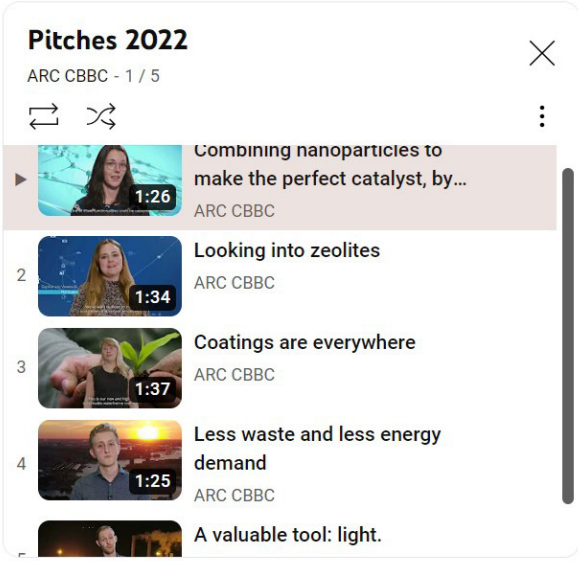
- Energy Transition Campus Amsterdam
- Summer School 2022

Top right: Visiting AkzoNobel during Summer School
Above: Enjoying dinner after a day of Summer School

Soft skill workshops

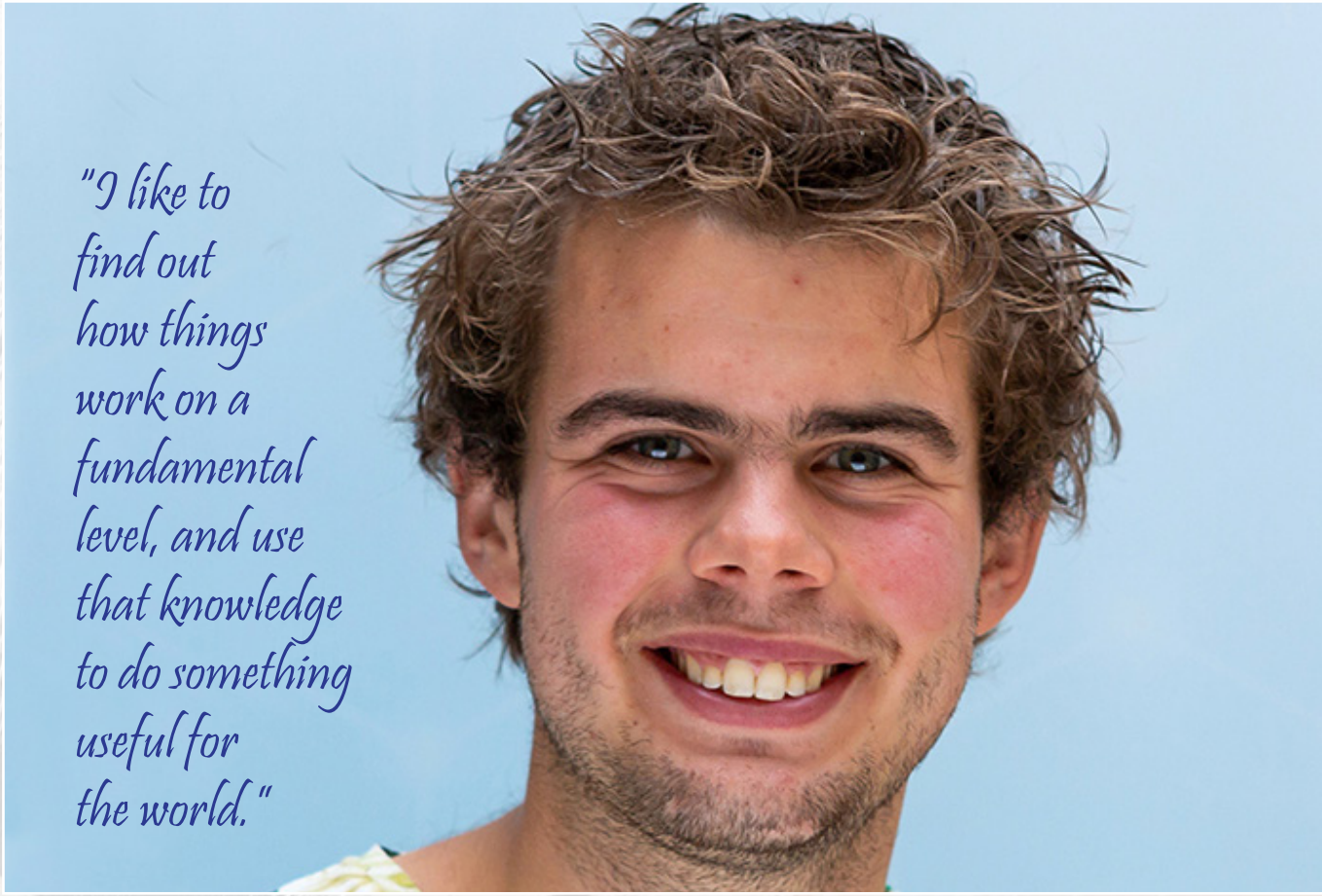
We believe that talent manifests itself in various skills. Being an excellent scientist is one, but also the ability to take on a leadership role or enthuse a lay audience for your work is important. All those qualities help shape the researcher of tomorrow. Within this context, we organized various training courses and workshops to bring our students' soft skills to a higher level: infographics, presentation and pitching workshops, as well as an outside-the-box planning and concentration skills course presented by Prof. Stefan Stigchel.

- Pitch Kelly Brouwer (UU)
- Pitch Sophie van Vreeswijk (UU)
- Pitch Sarina Maßmann (RUG)
- Pitch Kristiaan Helfferich (UU)
- Pitch Daan Groefsema (UU)



Ellard Hooiveld

Anyone who has ever painted a house knows that a single coat is hardly ever sufficient if you want your entire wall to be coated perfectly and uniformly in the paint of your choice. You often need to apply a second coat for a satisfactory result. That costs time, effort and – of course – more paint! Ellard Hooiveld is conducting a study at Wageningen University into paint that takes only a single application to produce a perfect result. Not only will this mean less effort; it also saves litres and litres of paint: a situation in which there are only benefits.



- Blog Ellard Hooiveld
- Interview Ellard Hooiveld in VVVF Magazine

However, developing paint of which a single coat is enough to produce a perfect result is more easily said than done. The paint has to have outstanding bonding capacities, while it must also be impervious to outside influences. Ellard aims to solve this problem by using particles in the paint that structure themselves during the drying process. This results in a soft layer on the inside that bonds easily to the painted surface and a hard layer on the other side that is capable of withstanding the weather conditions and temperature differences of the unpredictable world outside.

Of course, we are all eager to start using this perfect paint on everything we can. Unfortunately, we will still have to exercise some patience before only one coat of paint is enough for a fantastic result. Until then, we will keep a close eye on Ellard's research.

Sophie van Vreeswijk

Catalysts are of great importance to the chemical industry. Even though they themselves are not consumed, they help accelerate and facilitate chemical reactions. Catalysts come in a multitude of types and sizes. This is why it's important to understand how they work: only then can we deploy them as efficiently as possible. Sophie van Vreeswijk is contributing to this through her research at Utrecht University on zeolites, a special type of catalyst.

Pitch Sophie van Vreeswijk

The zeolites that Sophie is studying are used to convert methanol, which can be obtained out of several (mostly sustainable) sources into usable chemical building blocks. Traditionally speaking, fossil feedstocks are used to produce these chemical building blocks – to make plastics, for example. An alternative based on sustainable feedstocks is therefore highly desirable.

Sophie is examining the effects of modifying zeolites. Zeolites are very porous and contain a network of minuscule tunnels, the size of which determines the type of products formed in the reaction. The composition of a zeolite can also be a determining factor. Sophie has examined the way in which treating a zeolite with magnesium impacts the reaction. She has used different light-based techniques to study zeolites under real working conditions to examine the influence of the modification of the zeolites with different types of metals, for instance.

Sophie successfully defended her thesis in 2022 and is currently an alumnus of ARC CBBC.

"If we know when, where, how and why the reaction works, we can design and develop a very efficient catalyst."

Organization & governance in 2022

Executive Board (EB) Members
Prof. Dr ir. Bert Weckhuysen – *Scientific Director Utrecht University*
Prof. Dr Ben Feringa – *Chair University of Groningen*
Prof. Dr ir. Hans Kuipers – *Eindhoven University of Technology*
Ir. André van Linden – *AkzoNobel*
Dr Robert Terörde – *BASF*
Dr Frank Wubbolts – *Shell*
Dr Mathieu Ahr – *Nouryon*

The EB members are supported by the following knowledge experts:
Dr Jitte Flapper – *AkzoNobel*
Dr Peter Berben – *BASF*
Dr ir. Sander van Bavel – *Shell*
Dr Emma Winkels-Liaison – *NWO*

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Dr Dirk Smit – *Shell*
Dr Robert-Jan Smits – *Eindhoven University of Technology*
Dr Katrin Friese – *BASF*
David Williams - *AkzoNobel*
Joost Frenken - *University of Groningen*
Chair - *Vacancy*

The SB members are supported by the following observers:
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Dr Emma Winkels – *NWO*
Drs. Michiel Sweers – *Ministry of Economic Affairs and Climate Policy*

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Prof. Dr Joseph Keddie – *University of Surrey, UK*
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Prof. Dr Unni Olsbye – *University of Oslo, Norway*

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Dr Daniela Wilson – *Radboud University Nijmegen*
Prof. Dr Detlef Lohse – *University of Twente*
Prof. Dr ir. Emiel Hensen – *Eindhoven University of Technology*
Prof. Dr Erik Garnett – *University of Amsterdam*
Prof. Dr Evgeny Pidko – *Delft University of Technology*
Prof. Dr Floris Rutjes – *Radboud University Nijmegen*
Prof. Dr Frank de Groot – *Utrecht University*
Prof. Dr Freek Kapteijn – *Delft University of Technology*
Prof. Dr Guido Mul – *University of Twente*
Prof. Dr ir. Hans Kuipers – *Eindhoven University of Technology*
Prof. Dr Hans de Vries – *University of Groningen*
Prof. Dr ir. Jan van Hest – *Eindhoven University of Technology*
Prof. Dr ir. Jasper van der Gucht – *Wageningen University & Research*
Prof. Dr Joost Reek – *University of Amsterdam*
Prof. Dr ir. Kitty Nijmeijer – *Eindhoven University of Technology*
Prof. Dr ir. Krijn de Jong – *Utrecht University*
Prof. Dr Marc Koper – *Leiden University*
Prof. Dr Marjolein Dijkstra – *Utrecht University*
Prof. Dr Matthias Bickelhaupt – *Vrije Universiteit Amsterdam*
Prof. Dr Moniek Tromp – *Groningen University*
Dr Monique van der Veen – *Delft University of Technology*
Prof. Dr Nathalie Katsonis – *University of Twente*
Prof. Dr ir. Niels Deen – *Eindhoven University of Technology*
Prof. Dr Peter Bolhuis – *University of Amsterdam*
Prof. Dr Petra de Jongh – *Utrecht University*
Prof. Dr Pieter Bruijnincx – *Utrecht University*
Prof. Dr ir. René Janssen – *Eindhoven University of Technology*
Prof. Dr ir. Ruud van Ommen – *Delft University of Technology*
Prof. Dr Sijbren Otto – *Groningen University*
Prof. Dr Syuzanna Harutyunyan – *Groningen University*
Prof. Dr ir. Thijs Vlugt – *Delft University of Technology*
Prof. Dr ir. Wesley Browne – *Groningen University*
Prof. Dr ir. W.M. Wiebe de Vos – *University of Twente*
Dr Wilson Smith – *Delft University of Technology*

The following members have left in 2022:
Dr Daniela Wilson – Radboud University Nijmegen
Prof. Dr Frank de Groot – Utrecht University

Tenure tracks
Matteo Monai – *Utrecht University*
Eline Hutter – *Utrecht University*
Ina Vollmer – *Utrecht University*
Michael Lerch – *University of Groningen*
Sebastian Beil – *University of Groningen*
Nikolay Kosinov – *Eindhoven University of Technology*
Marta Costa Fiqueiredo – *Eindhoven University of Technology*

Technicians
Hannie van Berlo - van den Broek – *Utrecht University*
Ramon Oord – *Utrecht University*
Peter de Peinder – *Utrecht University*
Larry de Graaf – *Eindhoven University of Technology*
Brahim Mezari – *Eindhoven University of Technology*
Rafael Tarozo – *University of Groningen*

The following technician has joined in 2022:
Rafael Tarozo – *University of Groningen*

ARC CBBC Support Office
The ARC CBBC Support Office is hosted by the coordinating partner, Utrecht University. The composition of the Support Office in 2022 was as follows:
Anita ter Haar – *Financial Controller*
Hannah Thuijs – *Coordinator External Collaboration / Communication manager*
Anita den Heijer – *Office Manager*
Anne-Eva Nieuwelink – *Program Coordinator*
Julien Daubignard – *Project Manager*
Marijke Badings – *Communication Officer / Graphic designer*
Jeroen Meijer – *Communication Officer*
Bram van Reemst – *Data Specialist*
Juliëtte Meyberg – *Project Coordinator*
Masja Spijkstra – *Project Coordinator*

The following members have left the Support Office in 2022:
Juliëtte Meyberg – *Project Coordinator*

The following members have joined the Support Office in 2022:
Jeroen Meijer – *Communication Officer*
Masja Spijkstra – *Project Coordinator*

Our Publications in 2022

U. Agarwal, M.S. Rigutto, E. Zuidema, A.P.J. Jansen, A. Poursaeidesfahani, S. Sharma, D. Dubbeldam, and T.J.H. Vlugt, 'Kinetics of zeolite-catalyzed heptane hydroisomerization and hydrocracking with CBMC-modeled adsorption terms: Zeolite Beta as a large pore base case,' J. Catal., 2022, 415, 37-50, doi: 10.1016/j.jcat.2022.09.026.

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V.M. Caselli, J. Thieme, H.J. Jöbsis, S.A. Phadke, J. Zhao, E.M. Hutter, and T.J. Savenije, 'Traps in the spotlight: How traps affect the charge carrier dynamics in Cs2AgBiBr6 perovskite,' Cell Rep. Phys. Sci., 2022, 3, 101055, doi: 10.1016/j.xcrp.2022.101055.

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C. Liu, E. A. Uslamin, S. H. van Vreeswijk, I. Yarulina, S. Ganapathy, B. M. Weckhuysen, F. Kapteijn, Evgeny A. Pidko, 'An integrated approach to the key parameters in methanol-to-olefins reaction catalyzed by MFI/MEL zeolite materials,' Chinese Journal of Catalysis, 43, 7, 2022, 1879-1893, doi: 10.1016/S1872-2067(21)63990-6.

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F.J. de Zwart, P.C.M. Laan, N.S. van Leeuwen, E.O. Bobylev, E.R. Amstalden van Hove, S. Mathew, N. Yan, J. Flapper, K.J. van den Berg, J.N.H. Reek, and B. de Bruin, 'Isocyanate-Free Polyurea Synthesis via Ru-Catalyzed Carbene Insertion into the N–H Bonds of Urea,' Macromolecules, 2022, 55, 9690-9696, doi: 10.1021/acs.macromol.2c01457.

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Our new PhD candidates

In 2022, we have welcomed a fair amount of new PhD candidates.
Click them to learn more!

Alexandra Matei
(RUG)

Isil Yesil Gur
(TU/e)

Jadwiga Poniatowska
(TU/e)

Sven Weerdenburg
(TUD)

Aleksandra Wawrzyniak
(Leiden University)

Tessa de Koning Gans
(UT)

Adrian Hergesell
(UU)

En Chen
(UU)

Rens Ham
(UvA)

Ashique Lal
(UvA)

Rohit Raj
(AMOLF)

Jens Tolboom
(UvA)

Imke Bartels
(RUG)

Martijn de Heer Kloots
(WUR)

Jarne de Jong
(RUG)

Andries Jensma
(RUG)

Our new Postdoctoral researchers

A significant group of postdoctoral researchers has also joined us in 2022.
Click to learn more!

Chunning Sun
(UU)

Ruben Andringa
(RUG)

Mathieu Lepage
(RUG)

Prathap Kaniraj
(RUG)

Dhanya Babu
(RUG)

Daniela Rodrigues Silva
(VU)

Peter McNeice
(RUG)

Xinwei Ye
(UU)

Sreenithya Avadakkam
(TUD)

Disha Jain
(UU)

Loreta Muscarella
(UU)

Our Alumni

There is a time for hello, and a time for goodbye.
Six PhD candidates have defended their theses in 2022,
and have now taken the next steps in their careers.

Lukas Wolzak (UvA)
Researcher
at AkzoNobel

Linda Eijsink (RUG)
Postdoctoral fellow
at Göttingen University
Germany

Sophie van Vreeswijk (UU)
Project Leader Volta
at Greenerity GmbH
Germany

Chuncheng Liu (TUD)
Senior Research Specialist
at Dow

Akansha Goyal (UL):
Product Developer
at Greenerity GmbH Germany

Sanjana Chandrashekar (TUD)
Research Scientist
at Battolyzer Systems

IN NUMBERS 2016 - 2022

5
Industrial Partners
AkzoNobel
BASF
Shell
Nouryon
Nobian

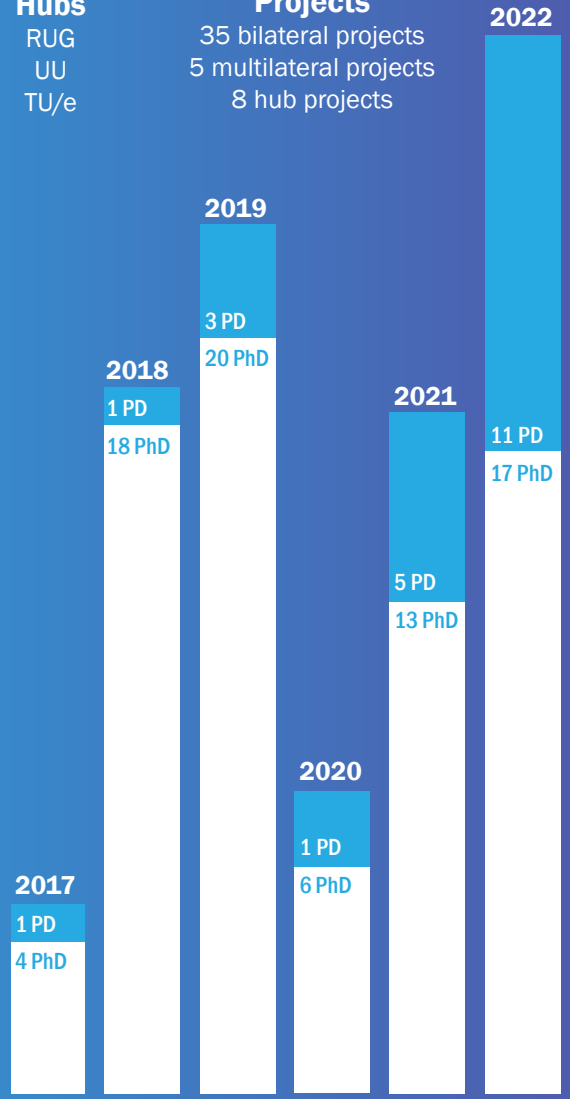
3
Hubs
RUG
UU
TU/e

48
Projects
35 bilateral projects
5 multilateral projects
8 hub projects

6
Defenses in 2022

40
Female Researchers

60
Male Researchers



Start of New Researchers per Year

Total of Researchers per University in 2022