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collaborations with physicists, mathematicians and biologists that will last beyond the International Year. The planet faces many problems and we can all contribute to attenuating the impact that we have on the planet and educating the younger generation to be better equipped with full support from knowledge of the basic sciences to deal with the challenges that we are facing and will continue to face.

The closing ceremony of IYBSSD will be at CERN in Geneva, Switzerland on 6 October 2023.

<https://www.iybssd2022.org/en/about-us/>

<https://www.unesco.org/en/year-basic-sciences/launch>

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Making Global Green Connections: The Importance of Green Chemistry Summer School for Sustainable Development

by Akwaowo Inyangudoh, Beatriz Chícharo, Giovanna Mazzi, Seyyed Emad Hooshmand, Gizelle van Niekerk, Lyvia Menezes, Fábio G. Delolo, Amy Naylor Randles, Fabrizio Politano, María Luz Tibaldi Bollati, Zikhona Tywabi-Ngeva, and Zikhona Tshemese

The chemical industry, backed by chemistry research has always played a vital role in economic development through problem-solving and the provision of societal needs. In tackling today's climate change, energy, food, and water crises, the role of chemistry can be re-vitalized based on green chemistry principles [1]. The birth

of green chemistry has over the years challenged and opened up new opportunities to chemists globally both in academia and industry. These opportunities include capacity building and education in Green Chemistry. The brightest example is the formation of the Green Chemistry Postgraduate Summer School (GCPSS) which has been actively promoting Green Chemistry Education and training young green chemists from around the globe. The contributors of this report were all attendees in the 2022 Summer School.

The very first edition of the GCPSS was held at the San Servolo island in Venice (Italy) and organized by the *Consorzio Interuniversitario Nazionale "La Chimica per L'Ambiente"* (Interuniversity Consortium "Chemistry for the Environment", INCA) in 1998 [2]. The GCPSS targeted young chemists (under the age of 35) from Europe and was funded by the European Commission's IV Framework Program, United Nations Educational, Scientific and Cultural Organization (UNESCO), the North Atlantic Treaty Organization - Advanced Science Institute (NATO-ASI) as well as the Training and Mobility of Researchers (TMR) program [3-5]. Nine editions that followed after this (until 2008) were all organized and managed by the INCA [2,3]. The 11th edition of the GCPSS was taken to the African continent (Dar es Salaam, Tanzania) and was organized by the IUPAC Interdivisional Committee on Green Chemistry for Sustainable Development (ICGCSD) [6]. In 2020, the world was impacted by COVID-19 pandemic and as a result, the 12th edition was held online for the first time. The online program had a total of 180 participants from 42 countries; the highest number recorded in the history of the GCPSS. This 12th edition was held in collaboration with ICGCSD and organized by the Green Sciences for Sustainable Development Foundation



Demographic distribution of students at the 14th GCPSS.



Group photo of in-person attendees of the 14th GCPSS and lecturers after the boat trip to the fascinating islands of Torcello and Burano.

(GSSDF) [7,8]. Organized also by the GSSDF, the 13th edition took place from 4-9 July 2021 in a hybrid format. The online and onsite student attendees summed up to 130 (15 onsite and 115 online) from 39 different countries [9].

This year, the 14th GCPSS was held again in Venice, from 3-8 July 2022. Besides the resonance of this event witnessed by all participants that joined from all over the world, this edition felt special because it counted with overwhelming onsite attendance after lockdown. The founder of the GSSDF, Pietro Tundo, expressed many times his deep joy in seeing all the people gathered there to exchange ideas and share knowledge on Green Chemistry for Sustainable Development. Moreover, Prof. Tundo, together with the organizing committee consisting of Fabio Aricò, Aurelia Visa, and Mirabbos Hojamberdiev, decided to also maintain the online platform, to maximize students' attendance and participation, particularly to those from Global South. The event had 161 student participants (50 in-person and 111 online), from 45 different countries with 5% from South America, 1% from North America, 46% from Africa, 19% from Europe, 28% from Asia, and 1% from Oceania, as shown in Figure 1. Insightful lectures at the 14th edition of the GCPSS were delivered by 24 outstanding teachers (11 online and 13 in-person), from diverse backgrounds with one goal in mind: to

emphasize the importance of green chemistry and cutting-edge topics in this regard to the younger generation. Some of the hot topics discussed include continuous-flow reactions to produce pharmaceutical products, synthesis of biopolymers from waste, computational chemistry to develop greener chemical solutions, photochemistry, catalysis in carbon dioxide for biomass conversion, supramolecular dynamic chemistry, metal-organic frameworks, green process for green hydrogen production, and many others. The daily activities of the 14th GCPSS were updated on the IUPAC website in the form of a daily brief [10].

All students were given the opportunity to share their own research work with a 5-minute poster presentation with the aim to widen green chemistry knowledge and allow students to actively participate and interact. To recognize outstanding research works of attending students on green chemistry, PhosAgro, a long-time sponsor, generously provided 4 grants of 500 € each to award the best in-presence posters. In addition, the GSSDF gave 5 more prizes— an original reprint of Venice—to recognize the excellent research works of attending students who made the best online/in-presence participants. More information on the winners of both awards can be found in the brief post [10].

Since one of the major goals of the 14th GCPSS

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was to allow young chemists to build an international network, many activities on the agenda were planned to encourage mutual sharing; from the welcoming event to the boat trip, all of them allowed students and lecturers to know each other's realities, traditions, and points of view. The social events were indeed catalysts to build new connections between students and lecturers from the same field, with different valuable experiences, which could lead to future collaborations and mutual help between colleagues.

It is worthy to mention that green chemistry is critical to young researchers at the beginning of their careers, considering its framework for a sustainable future. The program helps to educate young minds regarding the importance of their work for the future generation. Therefore, some of the in-presence attendees openly share their excitement, satisfaction, and delightful feedback about the 14th GCPSS.

Fábio G. Delolo (Brazil)

More than developing and promoting the concepts of green chemistry, the 14th GCPSS was a way to connect people who are concerned about the future. These connections can amplify and catalyze the green transformation that our society needs. There is nothing nobler than global problems to be solved through collaboration. But in addition to collaborators, during the event, it was possible to build not only work-related collaborations but also friendships connected for a purpose. Together it seems that the challenges can be overcome and a long-awaited sustainable development can be reached.



Giovana Mazzi (Italy)

I didn't know what to expect, I had never participated before in something similar. I was a bit anxious but thoroughly curious. Day by day the brilliant lectures opened my eyes to the incredible and limitless applications of green chemistry. But what I felt the most was a growing



connection with students from various places, and diverse realities, all gathered there for seeking new knowledge on green chemistry. I felt their pride and satisfaction while presenting their research to other young chemists, feelings that I experienced too for the first time during this 14th GCPSS. Sharing cultures, traditions, ideas, and hopes, tightened this international network and led to an amazing week. The 14th GCPSS gave me the immense opportunity to dive into an international scientific environment and to grow, as a young green chemist, as a student, and as a person.

María Luz Tibaldi Bollati and Fabrizio Politano (Argentina)

Our continent, South America, benefits from rich natural resources, a big agricultural sector, and a diversified industrial base. In underdeveloped countries, industrial development is crucial for our progress. We believe that the development of new chemical procedures provides an effective way of using basic science to address several issues in a profitable manner; but we are convinced that the only way to reach those goals has to be linked with sustainable, environmentally friendly ideas. The development of green chemistry in



Latin America is strongly engaged with education. The new generations of scientists need to be trained in methodologies, techniques, and principles that are aligned with green organic synthesis. Our participation in the 14th GCPSS allowed us to improve our expertise toward a green chemistry philosophy and expanded our research network, giving us the chance to discuss potential international collaborations. We could present our research in front of professors and students from all continents, being a golden opportunity for our professional development. The scholarships for less advantaged countries offered by the Organizing Committee and Sponsors, granted our participation in Venice, otherwise impossible, due to the travel cost from such a remote region. We bring home a lot of

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new experiences, friends and knowledge, and we are convinced that we will contribute as 'green chemistry ambassadors' in our countries to encourage more students to participate in such a wonderful event in the incoming years.

Beatriz Chícharo (Portugal)

I strongly and heartedly believe that the week of the 14th GCPSS in Venice changed my perspectives for the future. As a newly graduated Master of Bioorganic Chemistry, I jumped at the opportunity to attend an event of this dimension that allowed me to learn from pioneers of green chemistry and to share the work I have been doing for the past 7 months. Not only did the summer school enable me to gain a greener mindset for future work but also increased my network of contacts within our field. I'm firmly convinced that this type of event is imperative to educate young green chemists and prepare them for the inevitable battle they will have to fight for a greener future.



Gizelle Roque van Niekerk (South Africa)

As a 1st-year MSc student from the developing country of South Africa, I am grateful to Pietro Tundo for seeing potential in me as a young scientist by selecting me to attend the in-person event on scholarship. The 14th Green Chemistry Summer School was a life-changing experience and instrumental to my future career as a chemist. It was an honor to present my research at such a prestigious international summer school. The opportunity reinforced my belief that green chemistry solutions are a fundamental course of action for sustainable development in the Global South. It was a privilege to engage with postgraduate students from a broad spectrum of countries and I found the talks given by highly influential scientists very inspiring.



Networking with people who share the same common goal encouraged me to fervently continue my pursuits in the ground-taking field of green chemistry.

Seyyed Emad Hooshmand (Iran)

It was a second-to-none opportunity to share my research concerning multi-component reactions at the 14th GCPSS in Venice, Italy. Featuring 161 attendees from 45 countries worldwide, this was a tremendously amazing event about various green chemistry topics. It was also great to learn and interact with distinguished lecturers, for instance, Prof. Anastas, Prof. Matyjaszewski, Prof. Kappe, and Prof. König, who gave insightful lectures concerning green chemistry, ATRP, microfluidic systems, photocatalyst, respectively. Last but not least, I firmly believe that despite their minimal differences, humans are full of similarities. Sincere meetings of a substantial number of young green chemists from 45 countries of the world, regardless of nationality, color, religion, language, etc., demonstrates that *science is a universal language*.



Akwaowo Imoh Inyangudoh (Nigeria)

The week-long 14th GCPSS was intriguing and impactful! It has shaped my thinking about my future research to always consider a greener approach. Towards a sustainable future, this program has achieved three interesting things: (a) diversity and inclusion; it helps to level up the science around green chemistry, especially that of low economies; (b) targeting and recognition of young scientists from all over the world as the driving force and future impact makers; and (c) putting the principles of green chemistry on our minds and making us see their relevance in achieving the UN Sustainable Development Goals. Furthermore, the social event created an excellent atmosphere for networking and future collaborations.



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Our special thanks go to the organizing team and the Summer School sponsors.

Lyvia Nara Barroso Menezes (Brazil)

I've always dreamed about being part of an IUPAC meeting and in 2019, during the World Congress in Paris, I heard about the Green Chemistry Summer School, and to be part of the 14th edition was a dream come true. I had the opportunity to know chemists from all over the world who share the experience and love for science. Like many scientists from low-income countries, I finished my post-graduation after my 30's and I was a part-time student. The 14th GCPSS embraced me and gave me the fantastic opportunity to reconcile the desire to advance my career as a researcher and seek innovative environmental solutions. This is an essential steppingstone to making me an actor in charge of spreading global ideas and innovation on sanitation and waste-based biofuels production and applying green chemistry principles. IUPAC is concerned about the gender gap and this event made me feel enthusiastic about leaving a legacy of excellence for black women, particularly in the field of Green Chemistry.



Amy Naylor Randles (United Kingdom)

I was lucky enough to travel from the University of Nottingham to the 14th GCPSS in Venice with 7 of my fellow CDT colleagues, funded by the ESPRC CDT in Sustainable Chemistry. This opportunity allowed us to engage with other young green chemists from a plethora of countries, where we were able to discuss global and regional sustainability challenges and green chemistry project ideas. The many poster sessions and social events provided a platform for these detailed discussions. Two of my colleagues were given the opportunity to present their



first poster titled 'A greener route to the synthesis of monoarylphosphinic acids'. It was a privilege to present to a diverse range of young green chemists and this led to the development of many new ideas. The rest of the 14th GCPSS was filled with inspiring talks from some of the most prestigious green chemists from around the globe, including Professor Paul T. Anastas, alongside lots of good food, drink, and sunshine!

Zikhona Tywabi-Ngeva (South Africa)

I found the 14th GCPSS to have been amazing and enlightening. I started working on nanotechnology/nanomaterial research since 2015, but I was not really clued up on how to go about applying innovative solutions to the different industries through nanotechnology. I found the lecturers and their journeys in nanotechnology to be very inspiring and I'm feeling delighted to have been able to be a part of the 14th GCPSS. The content shared by the various lecturers was interesting and thought-provoking in a positive way. The 14th GCPSS also afforded the potential for nanotech research project collaborations, start-up collaborations, and postgraduate student supervision.



Conclusions

This GCPSS was held both in Venice and online, celebrating the end of uncertainty surrounding COVID-19-related travel restrictions. 161 postgraduate students attended (50 in-person and 111 online) from 45 different countries. Scientific lectures and other presentations from sponsors and invited speakers delivered engaging talks and motivated participants to do their part in promoting a sustainable future. Postgraduate students exchanged their knowledge through high-quality posters, which revealed their commitment to designing innovative green solutions. Students from diverse backgrounds were able to learn from each other and returned to their home countries inspired to advocate for the achievement of the United Nations Sustainable Development Goals. It was a great opportunity to network with people from a variety of cultures and speak the common language of science. The 14th GCPSS successfully brought together like-minded scientists from around the world who all share the same goal of promoting the field of green chemistry. Hence, we

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believe that the GCPSS successfully achieved another goal set for the 14th edition. Therefore, the GCPSS must continue in the years to come to tirelessly train young green chemists. So that the world will one day have more science leaders and science advocates with green chemistry minds for building a sustainable society. Wholeheartedly, we were a few young green chemists who got lucky enough to have the opportunity to attend the 14th GCPSS. However, there are thousands, if not millions, of young chemists from around the globe, who still wait to have this once-in-a-lifetime opportunity. Therefore, we hope that more sponsors will join Green Sciences for Sustainable Development Foundation (GSSDF), IUPAC Interdivisional Committee on Green Chemistry for Sustainable Development (ICGCSD), IUPAC, Organization for the Prohibition of Chemical Weapons (OPCW), PhosAgro, Zhejiang NHU Co., Ltd., BRACCO Group, SASOL, and GreeNovator in the future to support the attendance of more young green chemists, particularly from the Global South, to join the next editions of the GCPSS.

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On behalf of all the students who attended the 14th Green Chemistry Postgraduate Summer School, we would like to thank Prof. Pietro Tundo (Chairman) and the members of the Organizing Committee: Prof. Fabio Aricò, Dr. Aurelia Visa, and Dr. Mirabbos Hojamberdiev for organizing this remarkable Summer School on Green Chemistry.

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<https://iupac.org/event/xiv-postgraduate-summer-school-on-green-chemistry/>

International Polymer Characterization

by Chin Han Chan, Sven Henning, and Holger Schönherr

POLY-CHAR [Halle-Siegen] 2022 is an International Polymer Characterization Conference organized by Fraunhofer IMWS and Universität Siegen and under the auspices of the POLY-CHAR Scientific Committee. This was an IUPAC-endorsed conference and was sponsored by Groupe Nutriset.

With the purpose of unrestricted worldwide participation in times of global uncertainty regarding travel restrictions due to the COVID-19 pandemic, POLY-CHAR [Halle-Siegen] 2022 was organized as a live digital event from 22 to 25 May 2022. The conference's topics included polymer synthesis, polymer characterization, polymer physics, theory and simulations, circular economy of polymers and sustainable applications, polymers for biomedical applications, biopolymers, biomedical materials and biotechnology, biopolymers in nutrition and health, elastomers and amorphous materials, nanomaterials and smart materials, the economics of polymeric materials, mechanics of polymers, adhesives and coatings, advanced hybrid materials etc.

The scientific and organizing committees of POLY-CHAR were extremely grateful for the participation of more than 100 interdisciplinary participants from all five continents, who shared their research findings ranging from theoretical to experimental and fundamental to applied aspects of polymers. The program's

areas of competence were diverse.

A total of five plenary speakers, 24 invited speakers, 66 oral speakers, nine poster presenters from 28 countries participated in POLY-CHAR 2022 [Halle-Siegen].

The POLY-CHAR Short Course was held on the first day of the conference. Eight prestigious researchers delivered graduate-level tutorial presentations on the following topics:

- Analysis of polymer nano environments with AFM and time-resolved fluorescence methods – Holger Schönherr
- NMR for testing materials – Bernhard Blümich
- X-ray scattering in polymer science – Paul Topham
- Starch and glycogen: Two complex glucose polymers of importance to human health – A polymer science perspective – Bob Gilbert
- Polymer phase diagrams and what we can learn from them – Natalie Stingelin
- Random phenomena – Jean-Marc Saiter
- Advanced electron microscopy – Sven Henning
- Development in semiconducting polymer synthesis – Christine Luscombe

Outstanding researchers were honored with the POLY-CHAR awards, which are named in honor of three distinguished Nobel Laureates:

The **Richard Robert Ernst Award** went to Jianyong Jin, The University of Auckland, New Zealand; the **Jean-Marie Lehn Award** went to Zheng Li, Peking University, China; and the **Pierre-Gilles de Gennes Award** was awarded to José Luis Gómez Ribelles, Universitat Politècnica de València, Spain.

Three **POLY-CHAR prizes for the Best Oral Presentations** were awarded to:

- Ana Iglesias-Mejuto for the work on *3D-printing of methycellulose aerogels for bone regenerative medicine*.
- Max Müller for the work on *Chitosan-based nanogels for improved selective detection of pathogenic bacteria*.
- Giulia Guidotti for the work on *New poly(butylene succinate)-based polyesters for cardiac tissue engineering: From synthesis to cell differentiation on scaffolds*.

Three **IUPAC Awards for Best Student Posters** were presented to:

- Bruna Frugoli Alves for the work on *Production and characterization of EVA/palygorskite and EVA/montmorillonite nanocomposites and their evaluation as pur point reduces for waxy systems*.