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Q&A

Chem at 10: Jie Wu

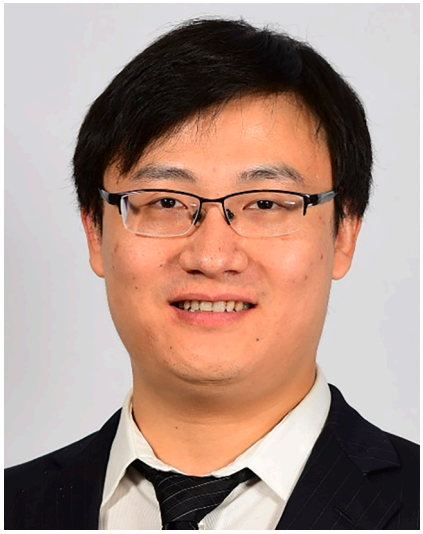
In his interview with *Chem*, Prof. Jie Wu reflects on a career shaped by curiosity, resilience, and molecular creativity. From his early inspiration in natural product synthesis to his advances in flow chemistry, automation, and sustainable synthesis, he emphasizes the importance of staying true to scientific curiosity while envisioning how artificial intelligence (AI)-guided tools for multistep automated synthesis could make the synthesis of complex molecules safer, faster, and more accessible.

Biography

Dr. Jie Wu is a professor in the Department of Chemistry at the National University of Singapore (NUS), where he also serves as the director of the department's MSc programs. He received his PhD from Boston University under the supervision of Prof. James Panek for work on natural product total synthesis. He then conducted postdoctoral research at the Massachusetts Institute of Technology (MIT) under the guidance of Profs. Timothy Jamison and T. Alan Hatton. During this time, he was introduced to continuous-flow technology. Dr. Wu is the founder of PhloSyn Pte. Ltd., an NUS spin-off company. His research focuses on flow chemistry, automated synthesis, and sustainable photochemical synthesis. He has received numerous awards, including the Dean's Chair Professorship, the Tokyo Chemical Industry-SNIC Industry Award in Synthetic Chemistry, the NUS Young Researcher Award, and Asian Core Program Lectureship Awards.

What would be a good non-scientific conversation starter with you?

A good non-scientific conversation starter with me is always travel and food. I enjoy hearing about people's favorite local dishes, memorable journeys, and daily routines because these stories often show a lot about culture and personality. I grew up in Sichuan Province, China, home of giant pandas and known for its bold and flavorful cuisine. There is an old saying: "Do not go to Sichuan when you are young," which jokingly suggests that life there is so comfortable that one might lose the drive to leave or strive for more. This saying has shaped me in a positive way. It taught me to appreciate life, good food, and meaningful moments



Jie Wu
Department of Chemistry, National University of Singapore

with others. I also enjoy traveling with my family and seeing how different people live, think, and make sense of the world. The world is wonderfully diverse, even when it is unfamiliar at first. Encountering different perspectives continues to broaden my view of life and keeps my mind curious and open.

Who or what originally sparked your passion for science and inspired you to pursue your current field of chemistry?

My path into chemistry did not begin with a grand plan. When I first chose chemistry as my major at university, the reasons were quite simple: I was not especially interested in abstract mathematics, and I liked that chemistry deals with things that really exist—molecules that can be made, transformed, purified, and held in a flask. This practical side of chemistry was very attractive to me. The key turning point came during my fourth undergraduate year when Prof. Guoqiang Lin, an academician of the Chinese Academy of Sciences, visited my alma mater and gave a seminar on natural product synthesis. I was fascinated by the idea that chemists could build highly complex molecules step by step, almost like assembling LEGO bricks at the molecular level. That lecture gave me a new vision of what I wanted to become: an architect of molecules, someone who could help build a more colorful world from the smallest pieces of matter.

That inspiration led me to pursue a PhD in total synthesis at Boston University. The preparation of the target molecules in my doctoral work often required 20–30 steps, and through this training I learned to appreciate both the elegance and the challenges of constructing complex molecules. Even today, I regard total synthesis as the "holy grail" of organic synthesis because it demands creativity, patience, precision, and a deep respect for the molecule itself.

During my postdoctoral training, I was fortunate to encounter continuous-flow technology. At first, I viewed it mainly as an engineering tool, but I soon realized that it offers a new way of thinking about synthesis and brings chemistry and physics closer together. What excites me most is that continuous-flow technology opens the door to automation. By controlling pumps and valves, we can start to imagine synthesis as something programmable. This vision continues to motivate my research today: the pursuit of push-button automated synthesis, in which complex molecules can be made on demand. In many ways, I am still pursuing the same dream that started from that undergraduate seminar—to build molecules like an

architect, but now with more advanced tools.

What are some challenges you have faced throughout your career, and how did you overcome them?

One of the biggest challenges I have faced as a researcher and professor is learning how to live with constant evaluation. In academia, many parts of our work are judged by others. Students decide whether our research is exciting enough for them to join the group. Funding agencies decide whether a proposal is important and realistic enough for them to support. Journal editors and reviewers decide whether a paper is novel and impactful enough for a broad scientific audience. These decisions are necessary, but over time they can also become a psychological burden.

In my early years as an independent principal investigator, I often worried too much about these judgements. When a proposal was rejected or a paper received critical reviews, I would immediately ask myself how to make people recognize the value of our work. This pushed me to improve, but it also sometimes made me lose focus on why I entered science in the first place. I gradually realized that external judgment is necessary, but it is not always objective. People can have different tastes and priorities. If I allow every outside opinion to define the value of my work, I will slowly lose my own sense of direction.

With time, I learned to return to something more fundamental: curiosity. To me, the key questions are whether the science truly excites me, whether it opens a new way of thinking, and whether it can bring meaningful change to the community. These are the forces that give me real satisfaction and happiness as a scientist. In Chinese, we often say "保持初心," which means to stay true to one's original aspiration. I believe that this is especially important in a scientific career.

Today, I still listen carefully to criticism and learn from feedback, but I try not to let external evaluation completely reshape my own standards or original purpose. I focus on doing science that feels meaningful and honest to myself. When I can remain curious, stay true to my values, and enjoy the process along the way, I feel that I am doing the kind of science I set out to do.

How could your lab's research contribute to building a more sustainable society?

Our lab's research contributes to sustainability by rethinking how molecules are made. Many pharmaceuticals, agrochemicals, and fine chemicals depend on organic synthesis, but traditional batch processes can be challenging at larger scales, energy intensive, solvent consuming, labor intensive, and sometimes hazardous. My group focuses on flow organic synthesis, automated synthesis, and sustainable photocatalysis to make chemical production safer, cleaner, more efficient, more reproducible, and more scalable.

Continuous-flow reactors offer many advantages over conventional stirred flasks. They make it easier to control reactions, automate processes, and scale up production. At the same time, flow chemistry also has limitations, such as clogging from solids and difficulties in connecting multiple steps. A major focus of our work has been overcoming these limitations by designing purpose-built flow platforms that make complex synthesis more practical in flow.

For example, we developed a stop-flow microtubing reactor that enables photochemical reactions with high-pressure gaseous feedstocks. We also created a solid-phase synthesis flow system in which intermediates are anchored on solid resins, helping to overcome solvent incompatibility between steps and enabling automated, diversity-oriented multistep synthesis. In addition, we built a high-speed circulation flow reactor with turbulence-enhanced mixing to address problems such as solid sedimentation and slow reaction rates, allowing batch conditions to be translated directly into flow on the 100-g scale. More recently, we established a "universal flow" platform for target-oriented automated multistep synthesis; this platform combines continuous operation with in-line monitoring and purification and has produced various active pharmaceutical ingredients. Some of these technologies have been adopted by other research groups and further translated commercially through our NUS spin-off company, PhloSyn Pte. Ltd.

Ultimately, our aim is to create a new generation of synthesis platforms that allow chemists not only to discover new reactions but also to control, automate, and manufacture them more sustainably. In this way, we hope to help move molecule synthesis from a resource- and labor-intensive craft toward a safer, smarter, more sustainable, and more scalable technology for society.

What exciting developments do you anticipate over the next 10 years, either in your specific field or in chemistry more broadly?

Small organic molecules are the chemical foundation of many important fields, including medicines, agrochemicals, advanced materials, and biological probes. In all of these fields, function depends on molecular structure, so constructing structurally complex molecules is the central mission of organic synthesis. We are now seeing one of the most significant technological shifts in decades: the rise of artificial intelligence (AI). AI has already changed how chemists think about synthesis planning and reaction optimization. However, a fundamental gap remains between planning and execution: AI can propose molecules and synthetic routes, but it cannot physically make the proposed molecules. The bottleneck is increasingly located in the "execution layer," where automated synthesis will play a key role.

Many single- and two-step transformations can already be automated quite effectively, but the molecules that matter most often require multiple carefully designed steps. Automating multistep synthesis is therefore not just about speed; it is also about making complex chemistry more accessible and reproducible. A major barrier is how to connect the steps, including workup and purification, in a reliable way.

I see two directions that are especially exciting. The first is target-oriented automated synthesis, where we aim to produce a defined complex molecule on demand according to a digital procedure while minimizing expert intervention at each step. Solving this problem could enable more flexible and distributed production of important molecules, for

example, during a pandemic or when supply chains are disrupted. Several pioneering systems have already pointed toward this future. Robotic chemists, end-to-end flow platforms, and cloud-based AI systems have shown how automation and AI can work together, but they also make clear that interstep purification and transfer remain major challenges.

The second paradigm is diversity-oriented automated synthesis, which asks whether a single automated workflow can enable the production of a diverse range of molecules and the more systematic exploration of chemical space. Discovery is fundamentally a search problem. If automated synthesis can make this search faster, broader, and more reproducible, hypotheses whose experimental testing currently requires months of specialist synthesis could instead be tested in days, and classes of molecules that are currently considered too demanding might become accessible. This approach also naturally generates high-quality, machine-readable experimental data that can feed into the next generation of AI models, creating a productive loop between computational intelligence and physical chemical execution. In this way, automation not only accelerates chemistry but also expands the range of molecules and reactions that chemistry can explore. Important progress toward this vision has already been made, for example, through the Burke group's iterative platform, which uses a unified, building-block-based workflow to automate small-molecule assembly and has helped to launch Excelsior Sciences. Its role in launching the company highlights the scientific and commercial interest in such approaches. In my group, our solid-phase synthesis (SPS)-flow system, which anchors substrates on insoluble resins and uses filtration-based purification with digital recipe files, represents one step toward enabling diversity-oriented automated synthesis on demand.

Looking ahead, I expect the next decade to bring more integrated platforms that combine AI, flow chemistry, automation, in-line analysis, and purification. Ultimately, I believe the field is moving toward an automated small-molecule synthesizer, analogous to peptide or DNA/RNA synthesizers. Achieving this would allow chemists to move more easily from designing molecules on a computer to making them in the laboratory. To me, this is one of the most exciting directions for chemistry because it could help close the gap between molecular imagination and molecular reality.

How has your experience been with publishing and reviewing for *Chem* and with engaging with the journal's editors?

My experience with *Chem* has been very positive and meaningful. The journal launched in 2016, shortly after I joined the NUS Department of Chemistry in 2015, so in a sense, *Chem* and my independent career have grown up together. Over the years, I have seen it quickly become a flagship chemistry journal with strong visibility across many subfields. I was fortunate to publish some of my group's best early work in *Chem*, and those papers played an important role in giving my young group confidence and recognition.

As an author, I feel that *Chem* has high standards not only for scientific novelty but also for clarity and broad interest. Publishing there encouraged me to think carefully about how to communicate our work to chemists outside our immediate area. For example, the editors sometimes asked us to explain why a particular problem matters or to highlight how a new platform could be used by others. This process helped me to move beyond simply reporting results toward telling a clearer scientific story. In that sense, publishing in *Chem* has helped me grow as both a researcher and a communicator.

I also appreciate the efficiency and professionalism of the editorial process. For our accepted papers, the editors and production team moved the manuscripts forward quickly, which is very important for authors. In addition, I have found pre-submission inquiries especially helpful. These discussions allowed me to test whether a piece of work was a good fit for the journal and to receive early guidance on how to position the manuscript. In several cases, the editors' comments at this stage led us to refine our message and to strengthen the way we framed the significance of the work before submission. Through these experiences, I have gained a lot of respect for the editors' scientific judgment.

As a reviewer, I value the chance to see new science at an early stage, but I also feel a strong responsibility. When I review a manuscript, I try to balance rigor with encouragement. I ask whether the experiments are solid, whether the claims are supported, and whether the work is presented in a way that will help the community. At the same time, I try to give comments that are specific and constructive because I know from my own experience how much thoughtful reviews can improve a paper.

Overall, my interactions with *Chem* have strengthened my appreciation for the role of a journal not only in publishing good science but also in supporting authors and reviewers as part of a larger conversation about where chemistry is going. For me, *Chem* has been both a platform for sharing our work and a partner in shaping how we present it to the scientific community.

DECLARATION OF INTERESTS

The author declares no competing interests.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the author used ChatGPT to polish the original draft for grammar and clarity. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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