



FACHUANG LU
Director, SKLPPE
Guest Editor

China's State Key Laboratory of Pulp and Paper Engineering

Editor's Note: TAPPI would like to thank Junyong (J.Y.) Zhu of the TAPPI Journal (TJ) Editorial Board, as well as Guest Editor Fachuang Lu, for developing this special issue featuring research from South China University of Technology and the State Key Laboratory of Pulp and Paper Engineering in Guangzhou, China.

– Monica Shaw, Editorial Director

The State Key Laboratory of Pulp and Paper Engineering (SKLPPE) at the School of Light Industry and Engineering, South China University of Technology (SCUT), is the only state key laboratory in the fields related to pulping, papermaking, biomass science, and engineering in China. Located at the SCUT campus and hosted by the School of Light Industry and Engineering, the laboratory was established in 1995 and approved by the China State Ministry of Science and Technology. Since it officially began operating in 1996, SKLPPE has witnessed visits and collaborative research from thousands of scholars and experts in the field of pulp and papermaking from all over the world. SKLPPE has become the most important platform for scientific research, academic idea exchange, and education in pulping and paper-related programs in China.

The laboratory was built around three key disciplines, including one national first-class discipline, Light Industry Technology and Engineering, and two national second-class disciplines, Pulp and Paper Engineering and Chemical Engineering, as well as several other related subjects. The laboratory motto is "Open, Dynamic, Collaborative and Competitive". An excellent working environment for academic activities has been built through establishment of comprehensive management regulations. The laboratory's goal is to lead sustainable developments in paper science and serve the nation's paper industry.



State Key Laboratory of Pulp and Paper Engineering at South China University of Technology in Guangzhou, China.

The laboratory now has 66 full-time personnel, including one academican of the Chinese Academy of Engineering and over 40 professors awarded with provincial or national honors. Most of the experts have a background in the field of pulping and papermaking, and the others are majored in material science, chemical engineering, food science and technology, resource and environmental science, and related fields. The laboratory's academic committee consists of 13 members who are all distinguished and outstanding scholars and experts in pulping and papermaking-related fields in China. The current committee chair, Professor Kefu Chen, is also the academican of the Chinese Academy of Engineering.

Flagship educational programs, outstanding graduates

SKLPPE offers experimental education and training primarily at the graduate level. Graduate students, especially students from the School of Light Industry and Engineering at SCUT, take advantage of the laboratory's

state-of-the-art facilities, performing research projects with the support of their supervisors. As an affiliate of the School of Light Industry and Engineering, the laboratory offers Master's and Ph.D. education to students with two programs: Pulp and Paper Engineering and Biomass Science and Technology. Most faculty members work as researchers and teachers for the undergraduate and graduate programs in the school. In the last five years, SKLPPE has matriculated over 300 doctoral students and over 750 Master's students. Currently, about 100 doctoral students and 230 Master's students are associated with the laboratory.

Graduates of SKLPPE from the Pulp and Paper Engineering program mostly find careers in pulping, papermaking, and related industries. For some time now, SKLPPE graduates have been found in virtually every major company in such fields. They have shown strong leadership and capabilities, playing important roles involving technology and management for these companies. Because of this, SKLPPE has been recognized as the flagship school in the field of pulping and papermaking in China.

Graduates from the program of Biomass Science and Technology have broader choices for their professional employment. Most graduates find careers as researchers at universities and research institutes throughout the world, and others find their professional paths in bioprocess industries, chemical industries, and related fields. Many SKLPPE graduates have had great success. In the past 10 years, over 40 distinguished scholars from SKLPPE have been awarded national honors.

Major research areas and accomplishments

Research at SKLPPE is primarily based on its two strong graduate programs, with total research funding in the past five years of more than US\$12.5 million from the government, Ministry of Education of China, Guangdong Province, and SCUT. SKLPPE members also receive funding from other foundations. SKLPPE keeps a very close relationship with industries and other institutes. In the past five years, SKLPPE has secured more than 360 national projects and 700 others, with total funding of about US\$55 million, from which almost US\$9 million comes from industries.

The laboratory has focused on solving problems associated with pulping and papermaking, including effluent management, environmental protection, plant resources,

In the last five years, SKLPPE has matriculated over 300 doctoral students and over 750 Master's students. Currently, about 100 doctoral students and 230 Master's students are associated with the laboratory.

processing equipment, and energy savings. In recent years, SKLPPE has expanded its research interests to biorefinery, bio-based materials, bioenergy, biochemicals, and other related topics. Based on the fractionation-transformation-application strategy for plant fiber utilization, the laboratory emphasizes fundamental and applied research in four primary areas: 1) pulping and pollution control; 2) papermaking and paper-based functional material; 3) processing equipment and intelligent management; and 4) biomass refinery, plant-derived bio-based chemical and nanomaterial technologies.

Through continual efforts, SKLPPE members have made significant progress in several major fields related to pulping technology, reducing effluent discharge, lignin utilization, paper-based functional materials, and cellulose nanomaterials. Some of these advances include:

- The optimal terminal point of cooking (transitional point from cooking to oxy-bleaching) was determined with comprehensive analysis and process modeling, allowing a major reduction in the overall operational cost of pulping.
- The scaling problem associated with nonwood pulping was solved thanks to our recent identification of the cause of scaling and methods to monitor it.
- Black liquor containing mainly kraft lignins has been processed to effectively produce fuel and chemicals using our patented technologies.
- Sophisticated treatment processes involving physiochemical, biological, and deep (advanced) oxidation for wastewaters discharged from paper mills have been developed, allowing the treated water to be reused or discharged along with satisfying the nation's strict regulations.
- Recycled paper/paperboard are important fibrous resources for papermaking, so SKLPPE members identified major influences on the quality of paper made from recycled fibers and invented a technology to improve/assure quality paper.

- A series of specialty paper products and fibrous paper-based composite materials have been developed in the laboratory, reducing the nation's dependence on imported products used by military, aerospace, rail transportation, and more.
- The integrated biorefinery concept for pulping and papermaking operations is a new direction that has been added to our research on traditional pulp and paper science. SKLPPE has brought in faculty/research members from disciplines of material science, renewable energy, biotechnology, food science, chemistry, and related fields to conduct fundamental and applied studies on biomass-related subjects.
- Great progress has been made in preparing metal catalysts, bio-based carbonaceous materials, organic-inorganic hybrid composites, bio-based films, and bio-based optoelectronic materials for various applications.

As a result of these and other efforts, over 1,700 scientific papers and 17 books have been published in the last five years. According to a Chinese scientific consulting service, SKLPPE was ranked in 2017 as the No. 2 worldwide research institute in the field of pulping and papermaking after Aalto University in Finland.

Expansive facilities and equipment

SKLPPE is comprised of more than 13,000 m² of space filled with over 800 instruments. The laboratory has both traditional and advanced equipment for education and research. The traditional equipment includes machines for pulping, papermaking, screening, bleaching, and more. These instruments are mainly for educating students from the Pulp and Paper Engineering program, after which they are directed to become professionals in pulping and papermaking industries. In addition, this traditional equipment is available for researchers to study pulping and papermaking processes. The advanced equipment includes machines like microfluidizers, homogenizers, freezing microtomes, and various reactors that are intended for biomass-related research and education. All instruments, including the testing instruments for pulp and paper, gas chromatography-mass spectrometry (GC-MS), liquid chromatography-mass spectrometry (LC-MS), high performance liquid chromatography (HPLC), and biochemical analyzers, as well as different types of electro-microscopes,

are employed for the education and research of both students and researchers.

All SKLPPE facilities are open to the public and shared with researchers from other institutes, universities, and industries around the world under agreement, which creates a strong platform of support for research and education in pulping, papermaking, and related disciplines.

Global collaboration

Researchers and experts from institutes, universities, and industries around the world are welcome to the laboratory for academic idea exchange and collaborative research. The laboratory also provides funding for post-doctoral and visiting researchers. Many projects are conducted through collaborations with domestic or overseas companies. In the last five years, the laboratory has had 17 international collaborative projects with total funding of about US\$1 million.

Hosting/organizing international conferences is another approach for connecting with scientists and engineers. The laboratory has held several international conferences, including the 5th International Symposium on Emerging Technologies of Pulping and Papermaking and the 3rd International Papermaking and Environment Conference held in 2016, as well as the Sino-German Symposium on Polysaccharides: New Chemistry and Materials in 2017.

Legendary Chinese papermaking moves toward future frontiers

It is well known that papermaking technology is one of the greatest ancient inventions originating from China. SKLPPE is determined to inherit the ancestor's wisdom and stand at the frontier of the pulping and papermaking field to solve problems encountered by the modern pulping and papermaking industry; develop novel processes for pulping, papermaking and related products; and make substantial contributions to the sustainable development of society and mankind. **TJ**

Fachuang Lu, Ph.D., is professor and director, State Key Laboratory of Pulping and Paper Engineering and dean, School of Light Industry Science and Engineering, at South China University of Technology, Guangzhou, China.