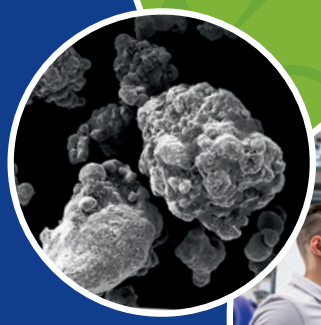
Hosokawa Powder Technology Foundation
(HPTF)

4th International
Hosokawa Powder
Technology Symposium

SUSTAINABLE PRODUCTION OF FUNCTIONAL PARTICLES



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HOSOKAWA ALPINE

WELCOME TO
AUGSBURG!

4th International Hosokawa Powder Technology Symposium

Message from the Organizer,

It is a great pleasure to announce that the International Hosokawa Powder Technology Symposium entitled "Sustainable production of functional particles" will be held at Dorint-Hotel Augsburg on Thursday 14th of September, 2023 as a part of special events to celebrate the 30th anniversary of the Hosokawa Powder Technology Foundation. This foundation was established in Japan for the purpose to promote science and technology in the field of powder and particle processing and characterization on the basis of the fund donated by the late Mr. Masuo Hosokawa. It annually presents the "KONA Award" to a prominent researcher with an excellent contribution to the advancement in this field and supports active researchers by financial funding.

This symposium is the fourth one to be held outside Japan by our foundation, which aims to promote the exchange of technical information and knowledge among worldwide researchers and engineers engaged in the work of handling powder and particles. The first one was held at HOSOKAWA ALPINE AG in Augsburg in 2014 on the occasion of 20th anniversary of the Foundation. And then the second one (2017) and the third one (2019) were held also successfully in USA and China, respectively.

While the environment surrounding the world is changing dramatically these days, technological innovation is steadily progressing to a great extent and the importance of powder science and engineering is considerably increasing more and more. I hope that this symposium will bring the participants new tips and ideas which will lead to innovative and fruitful R&D and engineering work in academic and industry.

Yoshio Hosokawa
President
Hosokawa Powder Technology Foundation

SPEAKER *Akira Watanabe*

Akira Watanabe is a vice division director of Powder Technology Research Institute at Hosokawa Micron Corporation in Japan. He received Ph.D. degree of engineering from Osaka University, Japan in 2008. He has been engaged in developing new powder machine and processing.

» THE DIFFERENCE BETWEEN GERMANY AND JAPAN FROM THE VIEWPOINT OF THE POWDER-RELATED INDUSTRY, AND SDGS

I worked in Germany for two years as a researcher and work in Japan for approximately two decades as a researcher and an engineer in powder-related industry. Based on my experience and thought, firstly, the difference between Germany and Japan is introduced in a general way. Secondary, from the viewpoint of the powder-related industry, the difference is discussed again.

As an example, the processes of positive electrode materials for secondary batteries are brought up.

Compared to ten years ago, the capacity of production is sharply increased due to the spread of electronic devices such as smartphones and electric vehicles. Secondary batteries are significantly related to SDGs. Finally, I would like to describe what is likely to happen in the future in this field through current inquires and market information.

SPEAKER *Christoph Thon*

Christoph Thon is a research associate in the group of Prof. Dr.-Ing. Carsten Schilde from the Institute of Particle Technology (iPAT) at Technical University of Braunschweig, Germany. He focuses on the application and development of AI techniques in the context of process engineering, specifically in the context of comminution, in close concert to experimental investigation and computer simulations such as CFD or DEM. Methodological focal points are neural nets, evolutionary algo-rithms, hybrid modelling as well as surrogate modelling, with the goal to amplify the incorporation of data driven techniques in modelling and R&D processes with respect to model transparency, efficiency and physical soundness.

» GRAPHITE SPHEROIDIZATION LEVERAGING AI IN PROCESS ENGINEERING: OVERVIEW OF MULTIFACETED APPLICATIONS AND SYNERGETIC INTEGRATION OPPORTUNITIES

The unprecedented surge in Artificial Intelligence (AI) capabilities, characterized by breakthroughs in deep learning technologies and the exponential growth in data collection and processing power, has led to transformative applications in process engineering, among others in the field of powder technology. This presentation delves into the multifaceted applications of AI in this field, with a focus on the integration of AI in processes of powder technology and on how different AI approaches, such as predictive modelling and AI driven process control, also considering accompanying experiments and simulations, can achieve great leverage.

Predictive and surrogate models often are the primary use of AI. Acting as quick to apply digital twins, they enable rapid iteration and virtual experimentation, substantially assisting optimization, design and control engineering. Moreover, they offer robust alternatives to demanding computational simulations, addressing challenges related to data constraints and computational capacity. In addition, AI finds use in calibration tasks, e. g. to efficiently identify fitting parameters for DEM simulations, such as frictions or coefficients of restitution. Such AI applications can also allow for the substitution of some experimental efforts via other, less challenging, ones. In addition, AI allows for the translation between different experimental and numerical approaches, opening further opportunities in time and cost reduction. Regarding the issue of AI's black box nature, hybrid or physicsinformed AI models offer solutions, engendering physically consistent models that enhance transparency and understanding.

In summary, the application of AI in process engineering, particularly in powder technology, is catalysing accelerated progress, cost reductions, and enhanced mechanistic insights. Not only does it optimize existing practices but also sets a foundation for future process engineering breakthroughs.

SPEAKER *Dr. Ir Gabrie.M.H. Meesters*

Gabrie Meesters is a professor in Chemical Engineering in the Product and Process Engineering group at the Faculty of Applied Sciences at the TU Delft. His focus is on Solids Processing and on Product Design. He graduated from Bio-Process Technology (1987) and did a PhD (1992) on droplet formation both at the TU Delft. He worked for 27 years at DSM research. The last 23 years he had a 0.2 fte appointment at the TU Delft in Chemical Engineering and 0.8 fte he worked at DSM Research in Delft. There he held several jobs in product design and fulfilled 12 years of Science Management in the Food and Nutritional cluster of DSM. Since January of 2019 he moved fulltime to the TU Delft. His research at the TU Delft has always been directed into designing products and processes related to particulate systems.

He holds over 20 patents and more than 60 refereed papers. He supervised 15 PhD's, 14 Engineering Doctorates (EngD), over 80 MSc's many BSc's students. He has organised several international congress and was the chairman of the world congress on particle technology (WCPT) and the Partec in 2010. He was involved in many international and national projects and is often seen as a speaker at many conferences. He was for 8 years the European editor for the particle technology journal KONA.

CURRENT TRENDS IN PARTICLE TECHNOLOGY

Particle processing, which involves the manipulation and control of individual particles, is an area of technology that is expected to face several challenges in the next decade. Here are some of the key challenges of which some will be discussed in this talk in more detail:

Scaling and integration: As particle processing technologies advance, one of the primary challenges will be to scale up the processes to handle larger volumes of particles.

Particle detection and characterization: Accurately detecting and characterizing individual particles is crucial for effective particle processing.

Contamination control: Particle processing often involves working with highly sensitive materials or devices, where even a small level of contamination can have a significant impact on the final product or performance.

Modelling and control: Artificial Intelligence (AI) and machine learning has the potential to revolutionize the field of particle processing by providing advanced tools and techniques to enhance various aspects of the process.

Particle-fluid interactions: Understanding and controlling the interactions between particles and fluids is essential for effective particle processing. Overcoming challenges related to particle agglomeration, sedimentation, and dispersion will be crucial for achieving efficient and controlled particle processing.

Scaling and integration: As particle processing technologies advance, one of the primary challenges will be to scale up the processes to handle larger volumes of particles.

Particle manipulation and assembly: Manipulating and assembling individual particles into desired structures or patterns is another significant challenge. Developing advanced techniques such as optical traps, microfluidics, and robotic systems will be crucial to overcome these challenges.

Energy efficiency and sustainability: Particle processing techniques often require significant energy inputs and generate waste by-products. In the next decade, there will be a growing emphasis on developing energy-efficient processes and sustainable manufacturing.

Integration with other technologies: Particle processing is often integrated with other technologies and disciplines, such as microelectronics, biotechnology, and materials science. Developing effective interdisciplinary approaches and collaborations will be vital for addressing complex challenges and unlocking new opportunities in particle processing.

SPEAKER *Konrad Opelt*

Konrad Opelt received his master degree in Material Science at TU Darmstadt in 2016. In 2017, he became a research fellow in the Department of Magnetic Materials at Fraunhofer IWKS. There he is responsible for the grinding technology. His scientific focus is on the grain boundary engineering of Nd-Fe-B magnets. In 2020, he started a PhD in cooperation with the research group Functional Materials of Prof. Oliver Gutfleisch at TU Darmstadt.

» PROCESSING TECHNIQUES FOR RARE EARTH MATERIALS AND THE EFFECT ON MAGNETIC MATERIALS PERFORMANCE

In recent years, the importance of high-performance rareearth (RE) based permanent magnets has increased rapidly since they are used in generators of wind turbines or electric motors of electrical vehicles (EV) underlining their standing for overcoming global climate change. Especially the demand for Nd2Fe14B-type magnets shows an enormous increase because of their high criticality due to geopolitical reasons. If they are used in EVs, even more, critical heavy REs (HRE) like Dy or Tb are necessary because they allow the usage at elevated temperatures up to 200 °C in the traction motors. Therefore, a lot of effort in research and industry is done for decreasing the criticality of sintered Nd-Fe-B-based magnets.

One important approach to reduce the criticality and finally the costs is to decrease the particle size of the sintering powder for Nd-Fe-B magnets. Conventional sintering powder has an average particle size of D50 ~ 5 µm. If the particle size is decreased to finer powder sizes like D50 ~ 3 µm the coercivity (resistance against demagnetization) of the final magnet is increased, allowing the usage at higher operating temperatures, or on the other side decreases the amount of HREs in the magnets. Another significant approach is the so-called 2-powder method (2PM). Hereby a coarser powder (D50 ~ 5 µm) and a finer powder (D50 ~ 2.5 µm) are blended and sintered afterward. Important is, that only the fine powder includes HREs leading to a special microstructure of the final magnet where the HREs are only located at defined regions, allowing to decrease the amount of HREs, too.

SPEAKER *Hermann Schmidt*

Hermann Schmidt studied process technology and bio process engineering at the University of Applied Sciences in Nuernberg Germany and works as Operations director of the Pharma division at Hosokawa Alpine AG in Augsburg, Germany. He has been working in the field of powder handling and grinding sector for pharma products more than 30 years and has extensive experience with various aspects of GMP and containment production subject. His experience ranges from smallest R&D systems up to multi-ton cell culture media plants including powder handling, containment, cleaning and sterile processes.

SPEAKER *Appachu Kodira*

A Chemical Engineer by training, with over 40 years of industrial experience. I have been part of Cell Culture Media industry for nearly three decades. I have been involved in the design of numerous Cell Culture Media manufacturing facilities on multiple continents. Extensive operational experience with start up and running of Cell Culture Media plants.

» THE FUTURE OF CULTIVATED MEAT AND THE CONTINUOUS PRODUCTION OF CELL CULTURE MEDIA

Cultivated meat is on the cusp of breakthrough, with great potential for transforming the food industry. As the world continues to increase its animal protein consumption, grappling with environmental degradation, industrial meat farms and viral contamination, cultivated meat offers a more sustainable alternative. The challenges of augmenting the existing protein meat supply with new technologies is well on its way. Cell culture media is an essential part of the cultivated meat eco-system. Production at the scale will be required to make a significant contribution to the success of this industry. This requires a complete rethink of the manufacturing processes of making cell culture media. The promise of massive transformation is scary and while sceptics raise caution, we have an opportunity to be part of the solution.

SPEAKER *Eric Emmert*

Eric Emmert is Senior Sales Manager Food Division pulses and local grains business segment. Eric has more than10 years of experience in global sales and market development in B2B and B2C in both Asian- and MENA working environments He has a first degree in Mechanical Engineering at university Kaiserslautern and an MBA in Marketing from university of Münster.

SPEAKER *Remy Kriech*

Remy Kriech is the Global Technical Sales Advisor of Bühler's pulses business segment. He has 25 years of experience in manufacturing, engineering, technology and sales. Remy started his Bühler career in 1998 as a Polymechanic Apprentice. After completion of the apprenticeship he became instructor for apprentices. In the last 12 years he has gained a lot of experience in the role of area sales manager for Milling Solutions and Pulses Protein Solutions, contributing to tackle the increasing number of opportunities in the plant protein environment. He is currently focusing and expediting the development of innovative technology solutions to extract the full potential of pulses (peas, beans, lentils, chickpeas and lupins) as a protein ingredient and valorize the resultant side-streams. Remy holds an Advanced Federal Diploma of Higher Education in Business Administration.

DEEP DIVE PULSES PROTEIN – COMBINATION OF DRY AND WET EXTRACTION

Meat substitutes using different protein sources than animal proteins have been existent for a long time – in the past however the texture and flavour were not mimicking real meat. These products were therefore tackling a small niche of vegan consumer who was willing to sacrifice taste and texture for the sake of animal protection. However, over the last decade, the increase in vegan and vegetarian food varieties and with that the market for meat and dairy analogues has increased steadily. On one hand down to healthier and cleaner lifestyle and on the other for sustainability thoughts, namely, to reduce the CO2 footprint of the consumed foods. Often the plant-based products are generated by combining the right amount of fat, starch, protein, etc. from pulses such us yellow peas, fava beans, lentils and Chickpeas. To achieve that the pulses have to be separated into a protein (rich) and starch (rich) fraction. This can be done in a wet or dry process. The dry process utilizes the different size of the starch and protein particles to achieve the separation. As the particle size distribution varies not only from plant to plant, but also from location to location and variety to variety different results may be obtained. When it comes to the wet process the process mainly used works with the isoelectric precipitation. The separation benefits from the adjustment of the pH value of the wet intermediate product. Both extraction methods have their own USPs which will be further elaborated in this session.

SPEAKER *Dr. Marilena Mancini*

Dr. Marilena Mancini is senior scientist responsible of the research topics graphite and carbons for battery applications and recycling of battery materials at the Accumulators Materials Research (ECM) Department of ZSW since 2013. She is working in the field of Li-ion batteries for 17 years, with experience in academy and industry. She obtained her PhD in Chemistry in 2009 from the University of Camerino (Italy). She is active in several national and international projects on different topics related to Li-ion batteries, with experience in cathode and anode materials and with specific focus on particle design and electrochemical analysis methods. She is a co-author of one patent and several original scientific papers on the Li-ion battery topic.

SPEAKER *Benjamin Biber*

Until June 2016: Graduation in environmental and process engineering with a master´s degree at Augsburg University of Applied Sciences. Since October 2016: R&D Manager in the powder processing division of Hosokawa Alpine with a focus on the development of graphite rounding processes.

SPHERONIZATION OF NATURAL GRAPHITE – BACKGROUND AND NOVEL PRODUCTION PROCESS

The demand for rounded graphite for lithium-ion batteries will increase rapidly in the next years, mainly driven by the growing number of electric vehicles and energy storage systems. Natural graphite will be a key material to meet the forecasted demand. Due to the required graphite particle properties and morphology, such as fineness, tap density and BET-surface area, a spheroidization process is essential to produce battery-grade natural graphite.

Nowadays, batch-wise operating classifier mills or continuously running classifier mill cascades are used for spheroidization. For natural graphite in particular, these processes are not very efficient due to their low yield and high energy demand. Furthermore, these processes have a huge space requirement when talking about an industrial scale production plant, as they need a large number of auxiliary equipment like filters and blowers. Therefore, we present a newly developed rounding process for natural graphite that has lower specific energy consumption and higher yield compared to existing processes. Another advantage is the smaller footprint of the new developed process for an industrial scale production plant.

These advantages are realized by dividing the complete grinding and rounding process into three independent unit operations: grinding, spheroidization and dedusting. This makes it possible to optimally adjust the number of machines and their size to each other. This gives the option to reduce the total number of machines and equipment in the spheroidization process.

SPEAKER *Carsten Schilde*

Carsten Schilde is a renowned professor at the Institute for Particle Technology (iPAT) at the Technical University of Braunschweig. He specialises in particle technology and process engineering. His academic journey began with a PhD on "Structure, Mechanics and Fracture of Nanoparticulate Aggregates" under Prof. Dr.-Ing. Arno Kwade, and led to a key role as a research associate and then professor for "Particle Simulation & Functional Structures" at the iPAT. Schilde's research involves the use of advanced simulation techniques and artificial intelligence. With over 130 publications, a Google Scholar H-index of 26 and over 2000 citations, his contributions to the field are substantial. His work has been recognised with the prestigious Friedrich Löffler Award in 2019. Alongside his academic endeavours, Schilde has been demonstrating leadership as the director of Lion Engineering since 2020. As of 2021, he has also been appointed to the prestigious Heisenberg professorship for Digitalisation of complex systems in process and production engineering.

» PARTICLE TECHNOLOGY IN LIB RAW MATERIALS PROCESSING

This keynote presentation examines the key role of particle technology, emphasizing comminution and dispersion, within the lithium-ion battery (LIB) lifecycle. Through a broad lens, it explores the complex applications of milling and classification techniques in active material production from primary raw materials and spent LIBs. Recycling of end-of-life (EOL) batteries is highlighted, focusing on the multi-step process involving shredding, separation, and milling of battery cells to derive 'black mass'.

The presentation underscores the importance of milling processes in the synthesis of cathode active materials. The increasing use of natural graphite as an anode material requires specialized milling and classification. It further discusses the production of nanosized silicon through nanomilling in stirred media mills and the dispersion of conductive additives, such as carbon black, emphasizing the vital role of particle technology in LIB production. Looking forward, the presentation casts light on the potential of mechanochemical synthesis, particularly for solid electrolytes.

As the global demand for battery cells continues to rise, sustainable mineral processing and recycling processes are underscored, not only to meet environmental goals but also to ensure a consistent material supply and establish a closed material cycle. The essential role of milling and dispersion techniques in cathode and anode material production is emphasized, significantly influencing the electro-chemical performance of LIBs. Envisioning the future, it posits a shift towards semi-continuous and continuous processes, marking a new era in LIB raw material processing.

SCAN ME *for your Feedback*

SUSTAINABLE PRODUCTION OF FUNCTIONAL PARTICLES

QUESTIONS?

Please contact us:

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