Report of the 10th International Conference for Dispersion Analysis and Materials Testing Berlin, virtual, 2022

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The 10th Dispersion Analysis and Materials Testing Conference took place virtually, for the first time, on January 24th and 25th, 2022. A record 90 participants, from a total of 23 countries, joined to expand their expertise and exchange ideas with other specialists. We were happy to host 9 renowned national and international experts who presented their latest research and results in the fields of Hansen dispersibility/solubility parameters, structure and separation analysis of real-world formulations and characterization of particle properties. Novel applications for industry and research were presented, all measured with LUM instruments [1].

The event was opened by the chairman of the scientific committee, Prof. Dr. Dr. Dietmar Lerche. His introduction provided a perfect prelude to the conference and focused on the latest applications of the LUMiSizer® dispersion analyzer and LUMiFrac® adhesion tester in the analysis of battery and hydrogen energy research. In addition, Dr. Lerche discussed the LUMiSpoc® single particle counter's application in both filtration and semiconductor research. At the end, Dr. Lerche presented, in his function as the Convenor of working groups WG 2 (Sedimentation) and WG 16 (Stability) of ISO-TC 24 / SC4, new activities on standards regarding dispersion analysis and material testing that would be useful for those working in industry.

Hansen Dispersibility and Solubility Parameters

Hansen dispersibility parameters, which build on the principles of the Hansen Solubility Parameter, are a fascinating new way of characterizing a dispersed material's interactions with its continuous phase, with great potential for optimizing standard operating procedures in an industrial and laboratory setting.

Sven Uwe Böhm of KRONOS INTERNATIONAL Inc. reported on the applicability of Hansen solubility parameters in the development of titanium dioxide pigments. The integral absorbance values provided by the LUMiSizer® were converted to relative sedimentation times, as described by Lerche et. al [2], and then analyzed to create a comparative study of Hansen parameters. This allowed pigment-matrix interactions to be successfully compared over various applications.

Titanium dioxide is also useful as a photocatalysts in the degradation of various volatile organic compounds [3]. **Osama Anwar** from the University of Duisburg-Essen presented an efficient method to compare different photocatalysts and their adsorption of volatile organic compounds. For this, Hansen parameters were determined using particle size distributions on the LUMiSizer®.

In his presentation, **Dr. Jörg Schuhmacher** from Schott AG described an approach for determining the optimum composition of multicomponent solvent mixtures for the dispersion of multicomponent particle collectives. To do this, he used sedimentation analysis in the LUMiSizer® described by Süß et. al [4], among others, to determine Hansen parameters. From these, optimal solvent mixtures for wet-chemical multicomponent coating materials were successfully identified.

In the production of fuel cell inks, platinum-loaded carbon is usually mixed and dispersed with water, organic solvents, and an ionomer. The interaction of the carbon particles with the liquid phase molecules mainly determines the stability of the ink. **Amin Said Amin** from the University of Duisburg-Essen presented his research on the use of Hansen solubility parameters to systematically study the

stability of carbon dispersions in different organic solvents. Following the concept of Hansen [5], he succeeded in identifying suitable solvents using the LUMiSizer® and the method presented by Süß et al [6].

Structural and Separation Analysis of Real-World Formulations

Prof. Dr. Timothy Hunter of the University of Leeds presented a comparison of sedimentation simulations of bidisperse colloidal systems (created from data from [7]) and the associated validation experiments using the LUMiSizer®. Spherical silica of three different sizes was used for the experiments and models. The results provided good agreement between simulation and experiment. In the discussion, Hunter emphasized the industrial significance of his findings for the further development of textile fabric softeners and of personal care products as well as titanium dioxide- and latex-based paints. Such simulations can be extended to other topics, for example, in better understanding the behavior of non-spherical, rod-like particles in nuclear waste-an area where practical laboratory and pilot-plant testing must be omitted.

Yuwen Meng of Le Mans Université has reported on the effect of xanthan gum on the stability of water-in-water emulsions based on POE (polyethylene oxide) and dextran [8]. Such oil-free emulsions are in particular demand in the pharmaceutical and food industries in order to avoid the use of surfactants. Ms. Meng referred to her plan to investigate additional polysaccharides, as well as further experiment on the influence of temperature on stability of water-in-water emulsions using the LUMiSizer®.

Modern approaches for the scaling-up of solid bowl centrifuges or decanters combines detailed modeling with material functions to predict the physical behavior of solid suspensions for separation processes. **Dr.-Ing. Marco Gleiß** from the Karlsruhe Institute of Technology (KIT) presented a prediction tool for the scaling-up of decanters based on small product volumes and test trials with the LUMiSizer®, which has the potential to minimize the effort needed in developing pilot plants. Here, Dr. Gleiß also referred to the work of Usher [9, 10] and, with his own contribution this year, delved deeper into the importance and potential of analytical centrifugation for industrial separation in the ever-increasing field of biotechnology.

Characterization of Particle Properties

Paola Cardenas Lopez of Friedrich-Alexander University Erlangen-Nuremberg has developed a new analytical method that enables the multiparameter characterization of both particle size and composition of noble metal alloy nanoparticles. Through validation with sedimentation simulations, she demonstrated that her approach of analytical ultracentrifugation with a multi-wavelength extinction detector is capable of determining 2D size-composition distributions with a high degree of accuracy. Ms. Cardenas Lopez elaborated on the possibility of the method being applied to other plasmonic systems such as bi-metallic core-shell particles and, for example, as in Uttinger et al [11], by means of analytical centrifugation (LUMiSizer®) with use of the new sector-shaped sensing cells.

Titanium dioxide particles, which have a plethora of uses in industry, tend to easily agglomerate. These agglomerates do not pack together well thus forming voids, which makes their effective density significantly smaller than the bulk material [12]. From these it is the average effective density of agglomerates that is critical for many studies including particle toxicology. **Dr. Horst Purwin** of KRONOS INTERNATIONAL Inc. has succeeded in studying sediments in detail using the LUMiReader®X-Ray to calculate the effective agglomerate density of titanium dioxide.

Young Scientist Award 2022

Since 2014, LUM has awarded a promising young scientist at each International Conference on Dispersion Analysis and Materials Testing. Unfortunately, in 2021 the conference had to be postponed, so this year applications from 2021 were included in the pool of applicants for the Young Scientist Award 2022. At the virtual conference, four nominees were invited to present the exciting findings from their respective theses. Important topics such as effective use of resources, reduction of pollutants, and transfer of mechanisms from nature to practice were discussed [13].

Lia Beraldo da Silveira Balestrin from Instituto Federal do Rio Grande do Sul presented an alternative experimental methodology to study the deposition of asphaltenes in a mixture of crude oil and n-heptane using inhibitors. Through the use of accelerated sedimentation analysis in the LUMiSizer®, she was able to demonstrate the effectiveness of inhibitors, which were normally neglected in traditional methods. In addition, it was possible to determine the minimum efficient concentration for the compounds, resulting in optimization for industrial use [14, 15].

Mussel-inspired catechol-containing polymers are a promising foundation for the development of strong biogenic adhesives. In her work, **Dr.-Ing. Charlotte Capitain** from Mannheim University of Applied Sciences developed a strong and sustainable bioadhesive by functionalizing chitosan with PCA (protocatecholic acid), which was produced from naturally occurring materials - without using toxic chemicals or processes. For a simplified and practical understanding of the rather complicated polymerization processes, the particle size distributions of chitosan, PCA-chitosan agglomerates and enzyme-catalyzed polymerization products were determined using the LUMiReader®PSA and compared with microscope images (subjective evaluation). For chitosan, there is very good agreement between the two different measurement methods [16]. The LUMiReader®PSA as an analytical, objective measuring instrument with extinction-based size distribution (according to ISO 13317) at different wavelengths once again shows its advantages in analyzing all polymerization products.

Additive manufacturing technologies enable the realization of lightweight design goals with increased integrated functionality. They have the potential to reduce material waste and enable flexible geometric design and a faster development cycle. **Inga-Malena Meyenborg** from the Fraunhofer IFAM Bremen has successfully used the LUMiFrac® adhesion analyzer to determine the tensile and fatigue properties of $AlSi_7Mg_{0.6}$ specimens produced using the additive manufacturing technique of selective laser melting. The simple and fast testing procedure, compared to conventional methods, saved both material and resources [17].

Mixing more than one agrochemical in a tank is a common strategy to simultaneously control different pests and plant diseases and reduce spraying times, thus reducing operating costs. However, mixing the different products can lead to physicochemical reactions, negatively affecting the action of the chemicals and even possibly poisoning the plants [18]. **Ana Beatriz Dilena Spadoni** from Universidade Estadual Paulista used LUMiSizer® measurements in order to study the separation stability of different mixtures of agrochemicals and demonstrated an improvement in stability by adding adjuvants.

The decision was not easy for the jury, but in the end **Lia Beraldo da Silveira Balestrin** was chosen as the winner of the LUM Young Scientist Award 2022. Lia was given the honor of receiving the coveted YSA trophy and won a prize of 1000 Euro. Congratulations Lia.

We are already looking forward to welcoming you to Berlin, in person, for the next International Conference on Dispersion Analysis and Materials Testing in 2023 or 2024.

We are now accepting applications for speakers with current research topic related to LUM instruments as well as for the LUM Young Scientist Award 2023/2024 (with your thesis from 2021 or more recent) via email at event[at]lum-gmbh.de.

The dates of the upcoming Conference will be officially announced soon.

We would be thrilled to add you to the appropriate email distribution list, upon request, so that you do not miss any information about the International Conference on Dispersion Analysis and Materials Testing. To let us know, please also write an e-mail to event[at]lum-gmbh.de.

References:

[1] Abstracts International Conference Dispersion Analysis & Materials Testing 2022, 24-25 January, 2022, www.dispersion-letters.com available online on 25.01.2022 16:37

[2] D. Lerche, S. Horvat, T. Sobisch: Efficient instrument based determination of the Hansen Solubility Parameters for talc-based pigment particles by multisample analytical centrifugation: Zero to One Scoring, Dispersion Letters, 2015, 6, 13-18

[3] S. G. Kumar and L. G. Devi: Review on Modified TiO2 Photocatalysis under UV/Visible Light: Selected Results and Related Mechanisms on Interfacial Charge Carrier Transfer Dynamics. The Journal of Physical Chemistry A, 2011, 115, 13211–13241.

[4] S. Süß, T. Sobisch, W. Peukert, D. Lerche, D. Segets: Determination of Hansen parameters for particles: A standardized routine based on analytical centrifugation, Adv. Powder Technol., 2018, 29, 1550–1561

[5] C. M. Hansen: Hansen Solubility Parameters: A User's Handbook, ISBN 9780849372483

[6] S. Süß, W. Lin, O. Getmanenko, L. Pflug, T. Sobisch, W. Peukert, D. Lerche, D. Segets: Suspension- and powder-based derivation of Hansen dispersibility parameters for zinc oxide quantum dots, Particuology: science and technology of particles Vol. 44 (2019) pp. 71 – 79

[7] E. Antonopoulou, C. F. Rohmann-Shaw, T. C. Sykes, O. J. Cayre, T. N. Hunter, P. K. Jimack: Numerical and experimental analysis of the sedimentation of spherical colloidal suspensions under centrifugal force, Physics of Fluids, 2018, 30, 030702; https://doi.org/10.1063/1.5010735 available online on 04.02.2022 13:26

[8] Y. Meng: Utilization of xanthan to stabilize water in water emulsions and modulate their viscosity, Carbohydrate Polymers, 2022, 277, 118812.

[9] S. Usher: Centrifugal Characterisation of Suspensions in Dewatering: Permeability, Compressibility and Elastic Rebound, International Workshop Dispersion Analysis & Materials Testing 2014, Berlin, Germany, 23-24 January 2014, www.dispersion-letters.com available online on 04.02.2022 13:24

[10] S.J. Skinner, L.J. Studer, D.R. Dixon, P. Hillis, C.A. Rees, R.C. Wall, R.G. Gavalida, S. Usher, A.D. Stickland, P.J. Scales: Quantification of wastewater sludge dewatering, Water Res., 2015, 82, 2-13

[11] M. J. Uttinger, S. Boldt, S. E. Wawra, T. D. Freiwald, C. Damm, J. Walter, D. Lerche, W. Peukert: New Prospects for Particle Characterization Using Analytical Centrifugation with Sector-Shaped Centerpieces, 2020, 37., 2000108

[12] J. M. Cohen, J. G. Teeguarden, P. Demokritou: An integrated approach for the in vitro dosimetry of engineered nanomaterials. Part. Fibre Toxicol., 2014, 11, 1-12

[13] Pressemitteilung, Von der Natur lernen, Ressourcen effektiver nutzen und schädliche Auswirkungen vermeiden: 5 Trendsetter für den LUM Wissenschaftspreis YSA 2022 nominiert, Berlin 14.12.2021, https://www.lum-gmbh.com/files/Presse/Presse%202021/Presse%202021/presseinfo_14_12_21.pdf available online on 25.01.2022 16:41

[14] L. B. S Balestrin and W. Loh: Recent Developments on the Elucidation of Colloidal Aspects of Asphaltenes and Their Relevance to Oilfield Problems. J. Braz. Chem. Soc. 2020, 31(2), 230-243.

[15] L. B. S. Balestrin, R.D. Francisco, C. A. Bertran, M. B. Cardoso: Direct Assessment of Inhibitor and Solvent Effects on the Deposition Mechanism of Asphaltenes in a Brazilian Crude Oil. Energy and Fuels, 2019, 33, 6, 4748–4757.

[16] C. Capitain, S. Wagner, J. Hummel, N. Tippkötter: Investigation of C–N Formation Between Catechols and Chitosan for the Formation of a Strong, Novel Adhesive Mimicking Mussel Adhesion. Waste and Biomass Valorization, 2021, Vol. 12(4), 1761–1779

[17] I. M. Meyenborg: A rapid testing method for fatigue in metal additive manufacturing, Bremen, Univ., Master Thesis, 2020, http://publica.fraunhofer.de/documents/N-606004.html

[18] J.F. Della Vechia: Interaction of spirodiclofen with insecticides for the control of in citrus, Pest Management Science, 2018, 74, 1-6.