ÖSTERREICHISCHE
GESELLSCHAFT
FÜR RHEOLOGIE

2ND ANNUAL CONFERENCE

OF THE AUSTRIAN SOCIETY FOR RHEOLOGY

17TH NOVEMBER 2023

LINZ

Johannes Kepler
University Linz
Altenberger Str. 69
Uni-Center, LOFT C
4040 Linz

Liebe Kolleginnen und Kollegen und an Rheologie Interessierte!

Die Österreichische Gesellschaft für Rheologie begrüßt Sie herzlich zur zweiten Jahrestagung in Linz.

Dieses Jahr sind wir – dank der Idee und Motivation von Prof. M. Kracalik und dem Institut für Polymerwissenschaften (Leiterin: Univ.-Prof. Dr. S. Hild) – zu Gast an der Johannes Kepler Universität, der „grünen Universität“ , in der wunderschönen Landeshauptstadt Oberösterreichs. Da in der ÖGR Rheolog*innen unterschiedlicher Fachrichtungen vertreten sind, wird es auch in diesem Jahr wieder eine Vortragsreihe zu unterschiedlichen Themen geben, beginnend am Vormittag mit biologischen Materialien und endend am Nachmittag mit einem starken Block zum Thema Baustoffe, organisiert von Prof. A. Robisson. Ich möchte die Keynotes von Prof. R. Cerbino und Dr. T. Liberto hervorheben. Während Prof. Cerbino über das zunehmend wichtige Thema Rheomikroskopie und Mikrorheologie sprechen wird, wird Dr. Liberto zur Problematik der Zementproduktion Stellung beziehen, die mit erheblichen CO2-Emissionen verbunden ist. Nach dem Mittagessen findet die erste Postersitzung in der jungen Geschichte unserer Gesellschaft statt. Ich freue mich schon jetzt auf die Präsentationen unserer jungen Kollegen; drei Poster werden ausgezeichnet.

Ich möchte allen, die an der Organisation mitgewirkt haben für ihr Engagement danken, diesen Tag zu einem großartigen Tag zu machen. Vor allem unserem Gastgeber Prof. M. Kracalik und seinem Team, die Großartiges geleistet haben, um diesen Tag zu ermöglichen.

Im Namen des ÖGR-Vorstandes wünsche ich Ihnen eine erfolgreiche Tagung!

Dear colleagues and those interested in rheology!

On behalf of the Board of the Austrian Society for Rheology, I warmly welcome you to our second annual conference in Linz.

This year - thanks to the idea and motivation of Prof. M. Kracalik and the Institute of Polymer Science (Head: Univ.-Prof. Dr. S. Hild) - we are guests at the Johannes Kepler University, the “green university”, in the beautiful state capital of Upper Austria. Since rheologists from different disciplines are represented in the ÖGR, there will be a series of lectures on different topics again this year, starting in the morning with biological materials and ending up in the afternoon with a strong block on building materials, organized by Prof. A. Robisson. I want to highlight the keynote speeches by Prof. R. Cerbino and Dr. T. Liberto. While Prof. Cerbino will speak about the important issue of rheo-microscopy and micro-rheology, Dr. Liberto will take a position on the problem of cement production, which is associated with significant CO2 emissions. After lunch, the first poster session in the young history of our society takes place. I am looking forward to the presentations by our young colleagues; three posters will be awarded prizes.

I would like to thank everyone involved in the organization for their commitment to making this a great day. Especially our host Prof. M. Kracalik and his team, who did a great job making this day possible.

On behalf of the ÖGR board, I wish you a successful conference!

Ursula Windberger
Conference chair

» One is never more certain of reality than when it is an illusion, because then it is reality by virtue of inner consent «

(Henri Michaux)

SPEAKERS & ABSTRACTS

2ND ANNUAL CONFERENCE
17TH NOVEMBER 2023

	SPEAKER	ABSTRACT TITLE
ORAL PRESENTATIONS	TH.-C. BAUER	Analysis of interactions in cerebrospinal fluid under different temperature conditions using rotational rheometry
	K.H. SCHNEIDER P. FISCHER	Rheometry in 3D bioprinting applications Role of the hydrophobic phase on interfacial phenomena of surfactants, proteins, and particles at fluid interfaces
	C. BACHLECHNER R.M. NOTHNAGEL ST. WURZER	Creation of a biofilm imitation based on rheological and tribological analyses Rheological characterisation of hydraulic lubricants for in hydrogen applications Characterization of the temperature and frequency dependency of the complex Poisson's ratio using a novel combined torsional-axial rheometer
	R. CERBINO N. KALAFATAKIS M. KOSTENKO	Rheo-microscopy and micro-rheology for soft matter KEYNOTE Building a strain and stress-controlled linear rheometer for rheomicroscopy Rheological insights into pet-clay polymer nanocomposites with functionalized clay: dispersion, behavior, and thermal effects
	L. SCHWAB L. NOIREZ	Characterization of natural and synthetic graphite for battery anode slurries Are there really viscous liquids?
POSTER PRESENTATIONS	D. AMSTUTZ B. STUCHLIK	Experimental observation of suspension sedimentation in a horizontal annular tube Investigation on cement slurries infiltration for the manufacturing of lightweight concrete
	R.M. NOTHNAGEL TH. KAUER K. STEINER	Assessing the potential of bio-based friction modifiers for food-grade lubrication Development and characterisation of a microorganism–free biofilm imitation Effect of surfactant type and storage temperature on flow properties of dermal o/w emulsions
	T. PFLEGER	Rheological parameters of Korean red ginseng extract as antioxidative ingredient in nanoemulsions: possible suitability for dermal preparations?
	A. WIERSCHEM	Shear rheology of methyl cellulose based solutions for cell mechanical measurements at high shear rates
	A. REINBACHER-KÖSTINGER V. GEIMER S.K. BASU E. BRADT L. NOIREZ	Shear-induced electrical conductivity changes in disturbed internal flow of human blood Plasticity of fibrin networks: human versus bovine Application of narrow gap rheometry in biology Application of macro- and microrheology for biological fluids A thermo-mechanical platform available at the Laboratoire Léon Brillouin
ORAL PRESENTATIONS	T. LIBERTO L. NASSERI	Challenges in the study of fresh sustainable construction materials KEYNOTE Comparison between cure kinetics by means of dynamic rheology of wood adhesives
	S. SUAREZ	Rheological characterization of functionalized wood adhesive with different conductive fillers
	T. BAKOVIC M. SHAHID	Rheological characterization of clay pastes for sustainable pourable clay concrete Fresh-mix properties of cement pastes containing graphene oxide: rheology and calorimetry
	S. SCHMID S. DHAR	Early-age creep of solidified limestone calcined clay cement paste Spherical balls settling through a quiescent cement paste

PROGRAM

2ND ANNUAL CONFERENCE
17TH NOVEMBER 2023

	SPEAKER	TIMELINE	CHAIR
9^{00}	WELCOME		
9^{15} – 10^{45}	Th.-C. Bauer K.H. Schneider P. Fischer C. Bachlechner R.M. Nothnagel St. Wurzer	09^{15} – 09^{30} 09^{30} – 09^{45} 09^{45} – 10^{00} 10^{00} – 10^{15} 10^{15} – 10^{30} 10^{30} – 10^{45}	Ph. Fuhrmann C. Bachlechner
10^{45} – 11^{15} COFFEE BREAK VISIT TO THE INDUSTRIAL EXHIBITION			
11^{15} – 12^{45}	KEYNOTE R. Cerbino N. Kalafatakis M. Kostenko L. Schwab L. Noirez	11^{15} – 11^{45} 11^{45} – 12^{00} 12^{00} – 12^{15} 12^{15} – 12^{30} 12^{30} – 12^{45}	K. Elsayad, M. Kracalik
12^{45} – 14^{00} LUNCH			
14^{00} – 15^{00}	Poster Session		S. Berner, R.M. Nothnagel
15^{00} – 15^{30} COFFEE BREAK VISIT TO THE INDUSTRIAL EXHIBITION			
15^{30} – 17^{00}	KEYNOTE T. Liberto L. Nasseri S. Suarez T. Bakovic M. Shahid S. Schmid S. Dhar	15^{30} – 15^{52} 15^{52} – 16^{03} 16^{03} – 16^{14} 16^{14} – 16^{25} 16^{25} – 16^{36} 16^{36} – 16^{47} 16^{47} – 17^{00}	A. Robisson, R.Ch. Kerschbaumer
17^{00} – 17^{30} POSTER PRICE AND CLOSING CEREMONY			
– 20^{00}	Conference Dinner at Restaurant Teichwerk		

ABSTRACTS ORAL PRESENTATION

17TH NOVEMBER 2023

ANALYSIS OF INTERACTIONS IN CEREBROSPINAL FLUID UNDER DIFFERENT TEMPERATURE CONDITIONS USING ROTATIONAL RHEOMETRY

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Rheology is considered to characterize the flow behaviour of different materials. In medical science rheology has little awareness. Some studies have been conducted on synovia and blood. This study focuses on cerebrospinal fluid (CSF) especially after subarachnoid hemorrhage (SAH). The aim is a closer investigation if rheology may help for better understanding of circulation disorders of CSF in the body.
The samples were drawn via an external ventricular drainage at different time points after the SAH. Rheological measurements were operated with a rotational rheometer (Anton Paar Ldt., Graz, Austria) equipped with a double gap geometry (DG26,7/T200/SS). Different conditions in the human body were simulated by measuring the samples at specific temperatures (5°C, 35°C, 37°C, 40°C), as the storage temperature in refrigerator – undercooled – physiologic – elevated body temperature. The frequency tests show a natural trend due to the different measuring temperatures. This specific data behaviour was investigated further. Moreover, new methodology was used to calculate viscoelastic based parameters as the cumulative storage factor, which was introduced in previous works. These parameters were correlated with laboratory parameters, as erythrocyte and leukocyte count, total protein, lactate and glucose concentration.
Relationships between the correlation of rheological and laboratory parameters and specific disease patterns of patients as well on the time elapsed since subarachnoid hemorrhage were observed. The overall goal is to evaluate whether rheological parameters have a clinical advantage and may help prediction of shunt dependence after SAH.

RHEOMETRY IN 3D BIOPRINTING APPLICATIONS

KARL H SCHNEIDER[1,2] , SABRINA ROHRINGER[1,2], MARVIN DÖTZLHOFER[1], PETER RIESS[1], FELIX POINTER[1], URSULA WINDBERGER[1], BRUNO K PODESSER[1,2], HELGA BERGMEISTER[1,2]

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2 Ludwig Boltzmann Institute for Cardiovascular Research, Vienna, Austria

The use of a rheometer in 3D bioprinting research has proven to be a critical method for evaluating various components involved in the process. This study focuses on the use of rheological analysis to evaluate hydrogel mixtures for their suitability as bioinks and to determine the viscosity of so-called support baths, which are essential for in-gel printing. The innovative approach is to print low-viscosity bioinks into a support matrix to ensure structural integrity until complete gelation.
We are using a MCR 102 rheometer (Anton Paar) equipped with temperature control system for our experiments. For going beyond rheology, we include compression and tensile tests on 3D-printed scaffolds. These tests aim to compare the biomechanical properties of the printed scaffolds with those of natural tissue, adding a crucial dimension to the analysis. Our testing strategies are currently being further optimized to provide deeper insights into the biomechanical behavior of hydrogels, the printing setup and the final 3D bioprinted constructs. Expected outcomes include a better understanding of the 3D bioprinting process, improved complexity of the constructs, and valuable insights into the biomechanical properties of the materials used. Ultimately, the research should more accurately replicate the natural properties of organic tissue and contribute to the production of biologically and clinically relevant tissue parts - an ambitious goal that aligns with the broader goal of advancing tissue engineering for therapeutic applications.

ROLE OF THE HYDROPHOBIC PHASE ON INTERFACIAL PHENOMENA OF SURFACTANTS, PROTEINS, AND PARTICLES AT FLUID INTERFACES

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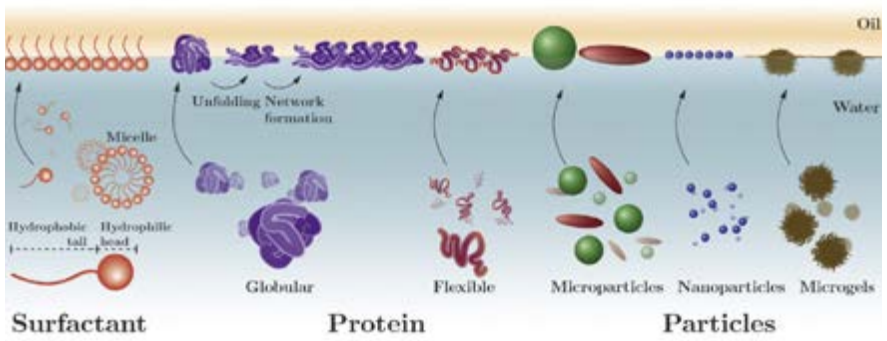
The formation of viscoelastic networks at fluid interfaces by adsorption layers is essential in many industries, scientific disciplines, and biological processes. However, the effect of the oil phase on the structural transitions of proteins, adsorption of surfactants and particles, subsequent network formation, and layer strength at fluid interfaces has received little attention in interfacial experiments and emulsion design. This has been the cause for significant inconsistencies in the scientific literature, as experiments were often performed at arbitrary oils, which impeded the reproducibility and comparability as well as hampers the pathway to a generic description. Here, we summarize the effect of the oil phase on the adsorption, assembly, and interfacial rheology of surfactants, proteins, and particles at fluid interfaces and the resulting influence on emulsions [1-6]. Furthermore, we provide experimental guidelines for using oils in interfacial experiments, aiming to harmonize results and protocols in interfacial science.



The adsorption of surfactants, proteins (globular and flexible), and particles (micro- and nano-sized and soft particles) to fluid interfaces [6].

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ABSTRACTS ORAL PRESENTATION

CREATION OF A BIOFILM IMITATION BASED ON RHEOLOGICAL AND TRIBOLOGICAL ANALYSES

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Biofilms are a major challenge in the food industry, as they can lead to contamination of food products and compromise their quality and safety. Hence, effective strategies against biofilms are needed. The use of biofilm imitations has emerged as a promising approach to anticipate e.g. the mechanical stability of biofilms. This study is part of the project BioMitate.
Methods: Based on literature, materials for the imitations were selected. Out of 52 formulations, 6 different imitations were chosen for characterisation to determine their mechanical properties. Moreover, a native biofilm was grown as a reference model.
Results: For the rheometer, imitations based on Gellan resulted in values ranging from 14.68 to 131.99 Pa for G' and from 4.07 to 6.00 Pa for G''. Imitations based on Alginate resulted in values of 16.30 to 23.33 Pa for G' and from 1.64 to 2.28 Pa for G''. In comparison, values for native biofilm models can range from 2 to 106 Pa for both G' and G'' (Böl et al., 2013). With the tribometer it was possible to narrow down the choice of the imitation.

Conclusions: By varying the formulations and their compounds, different rheological and tribological results can be achieved. Hence, it is possible to mimic all types of biofilms. After characterising cleaning relevant properties, imitations will be further used for cleaning tests.
Keywords: Biofilm imitation, food hygiene, cleaning relevant properties
Acknowledgements: This study was carried out under CORNET. Project-No.: FO999888198 and IGF-Project-No.:317 EBR.

RHEOLOGICAL CHARACTERISATION OF HYDRAULIC LUBRICANTS FOR IN HYDROGEN APPLICATIONS

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The growing market of hydrogen mobility and its supply chain often demands challenging properties from lubricants not comparable to more conventional solutions. In this work, a selection of hydraulic lubricants intended for mobile off-highway refuelling systems as pressure medium were rheologically, chemically and tribologically characterized to test their suitability. In this work, conventional poly alpha olefines (PAOs) are evaluated via an application-oriented rheometer method using the tribological set-up (ball-on-three-pins) on the rheometer MCR302. Further tests included the usage of the rheometer MCR302 rheological set-up (CC27 concentric cylinder) specifically used for low-viscous samples and the usage of the Oscillating friction wear tribometer (SRV). Comparing conventionally accessible PAOs with PAO-grade oils from sustainable sources, both are well designed to meet the demands of hydrogen refuelling. The PAOs from sustainable sources added the benefit of decarbonization of the lubricant media. Both the conventional PAOs and the PAOs from sustainable origin, indicate good viability due to their low viscosity at similar solubility and wear. In conclusion, PAOs from sustainable origin complete the circle of green mobility and should be considered for the overall green approach of this alternative fuel technology.
Key words: lubricants, hydrogen mobility, mobile off-highway refuelling systems, rheometer, sustainable

CHARACTERIZATION OF THE TEMPERATURE AND FREQUENCY DEPENDENCY OF THE COMPLEX POISSON'S RATIO USING A NOVEL COMBINED TORSIONAL-AXIAL RHEOMETER

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This study discusses the feasibility of using a combined torsional-axial rheometer to indirectly measure the complex Poisson's ratio based on shear and Young's modulus. Isothermal frequency sweeps in torsion and extension are performed sequentially on the same cylindrical specimen and under the same environmental conditions. The method is tested on two amorphous polymers, a semicrystalline polymer, a polymer blend, and a copolymer. The study includes an extensive literature review and an uncertainty assessment of the method to provide a basis for subsequent data comparison with existing research.
The experimental data show a monotonic increase in the complex Poisson's ratio up to 0.5 as the temperature approaches the α-relaxation for all samples except for the amorphous polymer. The latter shows a local minimum in the complex Poisson's ratio observed near the α-relaxation, which disappears after thermal annealing of the sample above the α-relaxation temperature.
The real and imaginary parts of the complex Poisson's ratio are additionally determined by evaluating both phase shift angles from torsional and extensional measurements. All polymers show a certain offset between the torsional and extensional phase shift angles in the glassy state, which gradually decreases as the temperature approaches the α-relaxation.
The complex Poisson's ratio results are in good agreement with literature data obtained by existing methods. This confirms that the method is applicable to polymers up to α-relaxation temperatures with significant time savings due to the non-destructive approach. This is of particular interest given the limited availability of data in the literature.

RHEO-MICROSCOPY AND MICRO-RHEOLOGY FOR SOFT MATTER

ROBERTO CERBINO

Computational and Soft Matter Physics, Faculty of Physics, University of Vienna, Austria

A crucial aspect in understanding soft matter lies in the interplay between the rheological properties, microstructure, and microscopic rearrangements. In recent years, there has been an escalating interest in devising new tools that employ light, among other probes, to garner microscale resolution information during rheological experiments. In this talk, I will outline recent advancements in the field obtained by my research group along with international collaborators. The first part of the talk will encompass recently devised passive microrheology approaches that facilitate probing the linear viscoelasticity of soft materials in a high throughput, operator-independent manner, overcoming known limitations of particle tracking based microrheology approaches. The subsequent part will concentrate on rheo-microscopy experiments conducted either with a custom-built rheometer or a suitably customized commercial rheometer. This approach, demonstrated here with some yield stress materials, holds potential for detailed exploration into the complex behaviors of a wide class of soft materials during rheological tests.

BUILDING A STRAIN AND STRESS-CONTROLLED LINEAR RHEOMETER FOR RHEOMICROSCOPY

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Traditional rheology usually fails to provide a comprehensive understanding of the dynamics of soft materials that are prone to shear instabilities. Experimental uncertainties, such as shear banding and wall slip, are known to impose a barrier when samples are subjected to large deformations, creating a knowledge gap for fundamentally and commercially important samples. Being able to reliably measure high shear and shear rate deformations are ambiguously important to be able to design and produce goods, but also to predict their properties at the application conditions and their failure precursors.
Despite the experimental approaches and data analysis techniques, the gap of reliable measurements and information at a microscopic level using traditional rheology remains, partially due to the shear-induced instabilities, but also due to the fact that theology offers an average of the macroscopic quantities such as viscosity, without offering information of the samples' dynamics at the constituents level.
Over the last few years, the simultaneous combination of rheology and microscopy has been successfully used to study shear-induced phenomena, like yielding, the transition from a solid to liquid-like behavior. Beyond the obvious advantage of visual inspection of the samples in the micro-scale, microscopy images under shearing can yield to information both in real and reciprocal space, using techniques like particle tracking or Digital Fourier Microscopy. This allows for quantitatively measuring shear-induced instabilities and studying the time-resolved evolution of their origin throughout all the volume of the sample, due to the simultaneous optical access to the sample, allowing to observe different levels between the shearing walls. So even under the influence of instabilities, one can still measure the real material properties at different distances from the wall, by performing microscopy.
Here we present a custom-made linear shear cell mounted on top of an inverted microscope and summarize the approaches proposed earlier discussing their advantages and weaknesses. Developing a feedback loop and utilizing control system knowledge, we build a simple but robust device able to perform high quality rheological measurements both in stress and strain-controlled mode, while operating microscopy on a commercial microscope. We offer a detailed presentation of the individual components and their importance, offering to the community unique know-how, and explain how one can perform sufficiently good rheology while utilizing the imaging capabilities of a microscope. The low cost of our shear cell being a fraction of the price of a modern commercial rheometer, along with the quality of the measured data, make our contribution a powerful toolbox in the hands of rheologists and microscopists, and makes more affordable the addition of rheometric capabilities for any lab that has available a microscope.

RHEOLOGICAL INSIGHTS INTO PET-CLAY POLYMER NANOCOMPOSITES WITH FUNCTIONALIZED CLAY: DISPERSION, BEHAVIOR, AND THERMAL EFFECTS

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Polymer nanocomposites have gained significant attention for their ability to enhance thermal, mechanical, and rheological properties through intricate component interactions. This study explores the fabrication of PET-clay nanocomposites using functionalized clay (CloisiteNa+), especially by grafted polymer brushes (poly(butyl acrylate) - (PBA) or poly(butyl methacrylate) – (PBMA)). The influence of CloisiteNa+ and its functionalized variant on thermal behaviors showcases a limited impact on flow temperature. Analysis of the complex viscosity showed that all prepared samples, except for PET with CloisiteNa+ fillers (industrial sample), exhibited typical liquid viscoelastic behavior. The composite incorporating CloisiteNa+ fillers (industrial sample) demonstrated shear-thinning behavior within a limited range of low frequencies. However, in the higher frequency range, the complex viscosity of PET composite systems with CloisiteNa+ fillers was higher than that in other samples, reflecting significant degradation reactions occurring during the processing stage. Analysis of storage modulus showed that clay-polymer nanosystems prepared with CloisiteNa+ exhibit "rubber-like" behavior, in contrast to the matrix and other nanocomposites where typical viscoelastic behavior was observed. Particularly noteworthy is the behavior of the CloisiteNa+-graft-PBA sample, which demonstrates the highest degree of dispersion and excellent filler-polymer matrix mixing. In general, the use of functionalized clay, especially with grafted brush, in the fabrication of PET-clay nanocomposites offers several advantages over "traditional" clay nanofillers. These advantages include enhanced compatibility between the clay and the polymer matrix, as well as tuned thermal, mechanical, and rheological properties of the PET nanocomposites. The presented results provide valuable insights into the properties of PET clay nanocomposites for various applications.

CHARACTERIZATION OF NATURAL AND SYNTHETIC GRAPHITE FOR BATTERY ANODE SLURRIES

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Electrode manufacturing for lithium-ion batteries is a complex, multistep process that can be optimized through slurry analysis and characterization. Electrode slurries are produced by combining active materials with binders, conductive additives, and solvent to produce a formulation that is: a) stable during storage, b) easy to disperse during the coating process, and c) produces a uniform coating. Process optimization requires thorough understanding of mixing, coating, and drying conditions. In this study, we focused on the effects of graphite from different sources on the viscoelastic properties of an electrode slurry.
With a new powder rheology accessory it was found that commercial graphite from large, industrial scale production shows lower cohesion and lower unconfined yield strength than graphite from a small scale commercial production. This can be explained by a more uniform particle size distribution and aspect ratio for the particles in the industrial grade, as revealed by microscopy. Natural graphite, both from industrial and commercial production, showed an even smaller cohesion and yield strength than the synthetic ones, which was due to particles of smaller sizes.
The difference between the graphite powders can alter the processability of the raw powder and its mixing into the slurry. Additionally, it affects the flow properties of the final slurry. A slurry made from synthetic graphite showed lower yield strength and thus the particles will more easily undergo settling and phase separation, which can lead to inhomogeneous distribution of the active material on the electrode and thus reduce battery performance.

ARE THERE REALLY VISCOUS LIQUIDS?

LAURENCE NOIREZ, PATRICK BARONI
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A solid body deforms under shear while a liquid flows. The absence of mechanical resistance to a shear stress indicates a liquid behavior. However, is this common definition really satisfying? Looking at the mesoscopic scale, we show that liquids and melts are actually endowed with shear elasticity that it is hidden in standard rheological measurements [1,2]. To prove the elastic nature of "liquids and melts", a new series of experiments highlight that ordinary liquids and polymer melts (glycerol, Polypropylene glycol, liquid water ...) are able to emit a modulated thermal (hot and cold) signal when submitted to a mechanical shear stress (figure 1)[3]. Thermal response is a collective effect. It is similar to the thermo-elasticity, coupling the deformation of an elastic (solid) body to its temperature and vice-versa. Such properties require long-range elastic interactions that are absent in current viscoelastic descriptions.
Our approach is an invitation to consider liquids as not fundamentally different from solids, highlighting splendid collective effects [3,4]. More than ever, a phononic interpretation is relevant, opening the way to coupling with surface boundaries, whether solid [5] or biological and defining an extended third zone.

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CHALLENGES IN THE STUDY OF FRESH SUSTAINABLE CONSTRUCTION MATERIALS

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Concrete construction is responsible for substantial CO2 emissions due to the vast consumption of cement, the most used man-made material worldwide. Cement shows exceptional mechanical properties, it is low cost and accessible globally. The majority of emitted CO2 is linked with its production stage (i.e., limestone decomposition during calcination). The use of sustainable alternative binders is indeed becoming increasingly urgent, requiring the adoption of advanced measurement techniques. On a material level, new sustainable formulations enable to partially or completely replace classical cement, bringing an additional complexity at the physico-chemical level of the pastes, requiring innovative characterization tools such as small oscillatory rheology (SAOS).
SAOS has been used to describe the viscoelastic behavior of sustainable cementitious pastes in time, providing macroscopic information about physico-chemical mechanisms occurring at the microscopic scale, otherwise challenging to access experimentally through direct measurements. Indeed, it has been shown that the evolution of the storage modulus (G') with time, imposing a deformation within the paste linear viscoelastic regime, tracks the development of interaction forces inside pastes and quantifies their cohesion.
Our findings on sustainable alternative cementitious pastes with different chemical composition (clay, slag, recycled concrete, recycled bricks), confirm small oscillatory rheology as a powerful macroscopic tool to measure interactions at the microscopic scale. Moreover, SAOS open a path to quantify the reactivity of these more sustainable binders in order to optimize their use in new recipes, thus reducing cement content.

COMPARISON BETWEEN CURE KINETICS BY MEANS OF DYNAMIC RHEOLOGY OF WOOD ADHESIVES

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Thermosetting resins are among the most important polymeric materials in today's wood industry. They undergo curing process by heating and form a three-dimensional network by crosslinking polymerization. A high curing reactivity is an important characteristic of an adhesive for wood applications. The degree of cure and the cure kinetics determine the manufacturing parameters as well as the performance of the wood-bonded composites. The evaluation of the rheological properties during polymerization is essential for a complete rheokinetic interpretation of the curing process. Therefore, rheometry can be used in parallel with other measurement techniques such as differential scanning calorimetry (DSC) to monitor the temperature-induced curing processes in crosslinking polymerization. However, it is difficult to compare the results obtained from rheometry and DSC, since they are unavoidably employed in different experimental conditions.
The so-called model-free (isoconversional) kinetic approach is used to evaluate the kinetic parameters of curing reactions resulting from rheometry and DSC. The model-free isoconversional method is used due to the complex nature of the curing reaction of formaldehyde-based wood adhesives. The rheological degree of conversion was compared with the chemical degree of conversion obtained by DSC and a relationship between obtained kinetic parameters is presented. Besides, the advantages and limitations of rheometry technique for determination of the curing kinetics of formaldehyde-based wood adhesives are discussed.

RHEOLOGICAL CHARACTERIZATION OF FUNCTIONALIZED WOOD ADHESIVE WITH DIFFERENT CONDUCTIVE FILLERS

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Timber structures can lose performance in case of undetected moisture ingress, and monitoring is frequently omitted or performed while it may alter the structure's integrity. Adhesive bondlines modified with electrically conductive fillers could be used to turn engineered wood into an embedded sensor system.
However, a certain electrical percolation threshold needs to be reached in order to have an electrically conductive network. This threshold is influenced by different parameters such as the viscosity of the resin, filler type, and dispersion quality which need to be determined experimentally.
The effect of different conductive fillers dispersed in melamine-urea formaldehyde resin on the electrical properties of the final composite and on the rheological properties of the adhesive is studied here.
The interactions between the filler and the resin are of interest for understanding the electrically conductive network and further combination of rheo-electrical measurements could provide more information on the internal structure of the different modified adhesives.

RHEOLOGICAL CHARACTERIZATION OF CLAY PASTES FOR SUSTAINABLE POURABLE CLAY CONCRETE

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The quest for sustainable construction materials has fuelled research into innovative alternatives to traditional cement-based concrete. Cement production contributes around 6% to 10% to global CO2 emissions, propelling the exploration of environmentally friendly alternatives. Considering the annual demand of approximately 4.1 billion tons per year, there is an urgent need for more sustainable alternatives. Among these, clay-based concrete has gained attention due to clays abundant availability and potential for a reduced environmental impact. This study investigates the fresh properties of locally sourced clays with a variable chemical and mineralogical composition. This early-age investigation is crucial for tailoring the fresh properties of pourable clay concrete.
To address this, rheological measurements were conducted to characterise the fresh behaviour of clay pastes. The use of rheology, particularly small amplitude oscillatory shear (SAOS), serves as a valuable tool in measuring the viscoelasticity of clay pastes at rest, as well their reactivity (i.e., cohesion development in time). This approach enables rapid assessment of clay paste performances within the initial hours, supporting the selection of promising compositions for subsequent mechanical evaluations in the solid state.
The investigation of locally sourced clays presents an opportunity to create clay-based concrete with tailored properties, thereby advancing sustainable construction practices. The insights gained through rheological analyses provide essential foundations for the production of clay-based composites, a core objective of the BasaltClayCrete project of which this study is part. With the critical challenges regarding cement CO2 emissions, embracing environmentally friendly alternatives like clay-based concrete is a fundamental shift towards greener construction practices on a global scale.
suitably customized commercial rheometer. This approach, demonstrated here with some yield stress materials, holds potential for detailed exploration into the complex behaviors of a wide class of soft materials during rheological tests.

FRESH-MIX PROPERTIES OF CEMENT PASTES CONTAINING GRAPHENE OXIDE: RHEOLOGY AND CALORIMETRY

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The effects of graphene oxide on the rheological performance and the reaction kinetics of freshly mixed cement paste gels is analyzed by means of small amplitude oscillatory rheology (SAOS), mini-slump cone spread tests, and quasi-isothermal calorimetry. Characterization of graphene oxide particles by means of the Particle Size Analyzer "Mastersizer 3000" by Malvern Instruments indicates that 50 percent of particles are smaller than 2 µm. Graphene oxide was dispersed in water using a superplasticizer and sonication. Cement pastes were prepared using graphene oxide at concentrations of 0.03%, 0.06%, and 0.09% by weight of cement and an initial water-to-cement mass ratio of 0.42. Results of the rheological measurements underline that graphene oxide decreases both the yield stress (at constant superplasticizer content) and the rate of stiffening. The calorimetry results show that heat release resulting from cement hydration is slower in the presence of graphene oxide. Thus, graphene oxide has a retarding effect on cement hydration. Early-age creep tests on solidified cement paste are currently being designed.
Keywords: Graphene oxide, cement paste, small amplitude oscillatory rheology, mini-slump cone spread tests, calorimetry

EARLY-AGE CREEP OF SOLIDIFIED LIMESTONE CALCINED CLAY CEMENT PASTE

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In Limestone Calcined Clay Cements (LC3), ordinary Portland cement (OPC) is partially replaced by limestone and temperature treated (= calcined) clay. This leads to less CO2 emissions in the cement production and, thus, to an improved eco-efficiency. The long-term serviceability of building structures is at stake because of the long-time creep behavior of concrete. The situation is particularly problematic in structures loaded at early material ages. This provides the motivation to examine early-age viscoelastic properties. Cylindrical samples of LC3 paste and a reference OPC are subjected, under isothermal conditions, to three-minutes creep tests. They are performed once every hour from approximately one day after paste production to a material age of seven days. The LC3-binder consists, by mass, of 70% OPC, 15% limestone, and 15% calcined clay. Both LC3 and OPC pastes are produced with an initial water-to-binder mass ratio amounting to 0.45. The reliability of the test results regarding elastic stiffness properties is confirmed by performing independent ultrasound pulse velocity measurements and evaluating them in the framework of the theory of elastic wave propagation through isotropic media. The increase of the modulus of elasticity of LC3 is initially slower and later faster than that of OPC, such that both materials exhibit virtually the same elastic stiffness some seven days after production. At the end of the observational period, the creep modulus of the LC3 paste is by 38% larger than that of the OPC paste. This indicates less creep activity of the LC3 paste than of the OPC reference. It is concluded that LC3 is a particularly promising binder for applications in building construction, where low creep activity is desirable.
Keywords: creep testing, hydraulic binders, limestone calcined clay cements

SPHERICAL BALLS SETTLING THROUGH A QUIESCENT CEMENT PASTE

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Fresh cement pastes are complex suspensions of micron-size cement particles (ground clinker) and nano-size C-S-H particles that result from a dissolution-precipitation process. They exhibit a colloidal behavior due to interactions between charged particles through an interstitial solution of high ionic strength, giving rise to a macroscopic yield stress, that increases with time at rest. Upon flow, this multiscale network is broken down (fluidized).
In this study, we investigate the evolving rheology properties of a cement paste in quiescent conditions by measuring the velocity of metallic balls settling in the paste using high speed X-ray CT imaging.
Once the cement is mixed with water, it is allowed to rest to develop the yields stress for a given amount of time in a cylinder of diameter 7 cm, time during which it is building up its microstructure and yield stress. We look at the influence of resting time on the velocity of steel balls falling through it. We vary the parameters of rest time, ball size (diameter 5 and 10 mm), ball weight and time interval between two successive ball drops. In parallel, an extensive rheological characterization of the paste, capturing the rheological properties "at rest" and under flow, focusing on the effect of time and shear history, is performed. Compiled results are then compared with literature of non-aging and aging yield stress fluids.

ABSTRACTS POSTER PRESENTATION

17TH NOVEMBER 2023

EXPERIMENTAL OBSERVATION OF SUSPENSION SEDIMENTATION IN A HORIZONTAL ANNULAR TUBE.

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This study presents an experimental exploration of suspension sedimentation within a horizontal circular annulus, as a model for cement paste. The integrity of hardened cement sheaths with no pre-existing defects has been extensively studied for the oil and gas, but geometrical defects coming from cement placement has not been discussed, motivating this study.
We mimic the water-cement suspension in the annular space with silicone oil and soda lime glass beads ranging in size from 25 to 500 µm. The annular cylinder has inner and outer diameter of ca. 90 and 140 mm, respectively, and a thickness of ca. 20 mm. It is filled the suspension, the oil representing the water and the beads the cement particles. The concentration of these beads is systematically varied, between semi-dilute (5%) and dense (ca. 45%) to reach typical value of cement particle concentrations.
The experimental procedure involves initially shaking the circular annulus to reach a uniform particle distribution in the cell, before allowing it to settle undisturbed while recording videos with a Canon EOS 80D camera at 30 fps. This approach allows us to observe how particles settle. Specific areas within the circular space, i.e., the poles and the equator region, are of particular focus. Furthermore, different particle tracking and velocimetry techniques were used to generate velocity profiles and monitor individual and collective motion of particles.
In summary, this study combines experimental investigation of suspensions, imaging and image treatment techniques to deepen our knowledge of particle sedimentation in horizontal circular annuli, which can help improve how we seal horizontal oil and gas wells with cement.

INVESTIGATION ON CEMENT SLURRIES INFILTRATION FOR THE MANUFACTURING OF LIGHTWEIGHT CONCRETE

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Our study focuses on the analysis of the infiltration of a cement paste into a pack of light weight aggregates made of expanded clay beads. Such infiltration is challenging because 1) cement paste is a dense suspension of water and ca. 45 vol% of 10 micron-size particles, and has a non-negligible yield stress 2) the paste needs to travel through a tortuous path formed by the packed beads, 3) the beads are themselves porous and if not pre-saturated in water, have been shown to pull water out of the cement paste and cause filtration, eventually preventing the pumping.
To investigate such systems, a set up was built where a cement paste is pumped through a pipe filled with clay beads, from the bottom to top. The pipe is instrumented with a pressure sensor that allows the measurement of pressure at the bottom of the pipe where the beads lay.
The influence of parameters such as bead size range, bead water pre-saturation and paste water-to-cement ratioon the pumping ability was explored. Rheological properties of the cement slurry as well as density and thermal conductivity of the hardened concrete were measured.
Eventually, mixtures of limestone calcined clay cement (LC3) were explored and the influence of the particle shape (from sphere to platelet) was studied. The rheology of the paste was also modified by changing the recipe (water-to-cement ratio, superplasticizer content, solid additive particle size distribution, admixtures), targeting a mixture with low segregation, low filtration ability, and thus improved ability to be pumped through the pack of beads.

ASSESSING THE POTENTIAL OF BIO-BASED FRICTION MODIFIERS FOR FOOD-GRADE LUBRICATION

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Sustainable and safe lubricants are used in a wide range of applications, reaching from the compressors and industrial machinery to devices used for e.g., food production. However, further development of these lubricants is essential to take a step towards a greener European economy. In this work, bio-based friction modifiers (FM) are evaluated via a food-application-oriented rheometer method using the tribological set-up (ball-on-three-plates) on the rheometer MCR302 by comparing them with conventional friction modifiers. The method development for the rheometer MCR302 was designed under variation of normal force [N], temperature [°C] and sliding speed [m/s]. Further, repeatability tests and accuracy determinations enclose the method development. Bio-based friction modifiers, such as rapeseed and salmon oil, could be a promising alternative for conventionally used fossil-based friction modifiers in lubricants. For sample selection, a toxicological assessment of literature data comparing conventionally used friction modifiers with a petro-chemical origin was performed. Based on the literature research, two different applications were considered: on the one hand the bio-based friction modifiers mixed in water and on the other hand the conventionally used friction modifiers mixed in a conventionally used oil polyalphaolefin. The performed tests indicate the advantages and disadvantages of both bio-based and conventionally used friction modifiers in the respective systems. Comparing the conventional FM in polyalphaolefin to the bio-based friction modifiers in polyalphaolefin at 80 °C and in distilled water at 30 °C, revealed that bio-based friction modifiers can perform at least as good as the best performing conventional friction modifier, namely tallow amine. Concluding, this study presents an essential step towards developing innovative sustainable technological solutions in lubricant research.
Key words: lubricants, lubricant additives, friction modifier, rheometer, sustainable

DEVELOPMENT AND CHARACTERISATION OF A MICROORGANISM–FREE BIOFILM IMITATION

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Background: A biofilm is an organised assembly of microorganisms that adheres to surfaces, to each other and are embedded in a self-produced matrix of extracellular polymeric substances (EPS). An accumulation of pathogens in biofilms can lead to health risks for consumers as well as a reduction of product quality, which in turn has a negative economic impact on the industry. Despite current hygiene requirements and the application of cleaning and disinfection concepts, the development of bacterial biofilms in the food industry is hard to avoid, and in many cases is discovered too late. Moreover, the cleaning process can be difficult, as biofilms have a higher resistance to external factors including mechanical, physical, and chemical stressors. Selecting appropriate cleaning procedures is crucial. Objective: The aim of this research is to establish microorganism-free biofilm imitations, and to achieve comparable features to a native biofilm. The imitations are composed of materials that can also be found in or associated with native biofilms. Methods: An AP MCR302 Rheometer was used. The rheological parameters storage modulus G´, loss modulus G´´, critical strain as well as the crossover point were analysed.
Results: The results show that the closest imitation considering the storage modulus G´ can be achieved with a hydrogel containing gellan gum and an equal amount of the salts sodium chloride and potassium chloride. Conclusions: It is highly complex to create a microorganism-free imitation that has characteristics similar to a native biofilm. Nevertheless, the information gained can be used for more detailed research. Particular attention should be paid to the individual components that make up the biofilm, understanding their interrelationships, and determining how their rheological characteristics can be linked to these components.

EFFECT OF SURFACTANT TYPE AND STORAGE TEMPERATURE ON FLOW PROPERTIES OF DERMAL O/W EMULSIONS

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The growing demand for sustainable and skin-friendly dermal formulations necessitates the use of components from renewable sources that do not exhibit any irritation potential. Phospholipid-based emulsifiers feature excellent biocompatibility and emulsifying properties and are therefore interesting alternatives to conventional surfactants.
To evaluate different phospholipid-based emulsifiers with varying content of phosphatidylcholine (PC) in comparison to conventional surfactants, fluid oil-in-water emulsions with 5% surfactant and 20% medium-chain triglycerides were produced by high-pressure homogenization and characterized over 8 weeks. Soybean-derived phospholipids Lipoid® S45, S75, S100 (60%, 74%, 97% of PC, respectively), PLPC80 (82% of monoacyl-PC) and egg-derived E80 (80% of PC) were compared to anionic sodium laureth sulfate and non-ionic polysorbate 80. The resulting emulsions were stored at either 8 °C or 21 °C to investigate the impact of storage temperature on physicochemical stability.
Dynamic viscosity was measured in dependence of shear rate (1 to 100 s-1) using a double-gap measuring system (MCR 302, DG27/T200/SS, diameter 27 mm). Flow curves were established, and general flow behaviour was assessed. Results showed that dynamic viscosity of the individual emulsions was dependent on emulsifier type: Lipoid® S45 and S75 showed pseudoplastic flow behaviour with dynamic viscosity of 25 to 75 mPa·s at a shear rate of 10 s-1, while the other surfactants were more fluid with viscosity below 10 mPa·s (at 10 s-1) and nearly Newtonian flow. Storage over 8 weeks led to substantial changes in dynamic viscosity in the range of ± 25% to 500% for Lipoid® S45, S75 and S100 at both storage conditions; the changes were more pronounced when stored at 21 °C. The other emulsions remained stable with changes below ± 10%.

RHEOLOGICAL PARAMETERS OF KOREAN RED GINSENG EXTRACT AS ANTIOXIDATIVE INGREDIENT IN NANOEMULSIONS: POSSIBLE SUITABILITY FOR DERMAL PREPARATIONS?

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Due to its anti-inflammatory, anti-infective and antioxidant effects, Panax ginseng and its root extract are commonly used as cosmetic ingredients in dermal preparations. However, only little is known about important technological aspects such as formulation strategies. Therefore, formulation studies were conducted to test the physicochemical stability of oil-in-water nanoemulsions and hydroalcoholic gels including KRG over 12 weeks. Dynamic light scattering, pH measurements and rheological assessments were conducted. In addition, the content and skin permeation of ginsenosides Rg1 and Rb1 were analyzed by UHPLC/MS. Highest storage stability and skin permeation was shown for carbomer gels containing 20% w/w of ethanol [1].
Besides the determination of flow curves, oscillatory shear studies are currently conducted. Parameters such as storage modulus (G') and viscous modulus (G'') will be determined to better compare the formulations in terms of flow properties. Measurements are done at different temperatures: We want to test rheological behavior of formulations both at storage temperature and at skin temperature of 32 °C for investigating their suitability for topical application.

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SHEAR RHEOLOGY OF METHYL CELLULOSE BASED SOLUTIONS FOR CELL MECHANICAL MEASUREMENTS AT HIGH SHEAR RATES

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Methyl cellulose is a widely used material in various microfluidic applications in biology. Due to its biocompatibility, it has become a popular crowding agent for microfluidic cell deformability measurements, which usually operate at high shear rates (> 10,000 s-1). However, a full rheological characterization of methyl cellulose solutions under these conditions has not been reported, yet. Here, we provide a shear-rheological description for solutions of up to 1% methyl cellulose dissolved in phosphate-buffered saline that are commonly used in real-time deformability cytometry.
We characterized three different solutions used for cell mechanical measurements by their viscosity functions and normal stress differences [1]. To cover a range of shear rates from 0.1-150,000 s-1, we employed three different shear rheometer setups: concentric cylinders, cone and plate and a narrow-gap device [2,3]. Viscosity functions can be well described using a Carreau-Yasuda model. Our results show that methyl cellulose solutions behave like power-law liquids in viscosity and first normal stress difference at shear rates between 5,000-150,000 s-1. We present the temperature dependency of shear viscosity and first normal stress difference of these solutions and construct a general viscosity equation for each solution at a certain shear rate and temperature. We found the entanglement concentration at around 0.64 w/w%. Our results help to better understand the viscoelastic behavior of methyl cellulose solutions, which can now be considered when modelling stresses in microfluidic channels.

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SHEAR-INDUCED ELECTRICAL CONDUCTIVITY CHANGES IN DISTURBED INTERNAL FLOW OF HUMAN BLOOD

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Human blood is a physically highly complex fluid that consists of cells (red and white blood cells and platelets) suspended in blood plasma. Experimental research has shown that the electrical conductivity and the viscosity are mainly determined by the properties of the red blood cells (RBCs) and the surrounding plasma. Furthermore, it has been observed that the alignment and deformation of the electrically isolating RBCs suspended in the well-conducting blood plasma causes the blood conductivity to become anisotropic in case of flowing blood, i.e. it is higher in the direction of flow and lower in orthogonal direction. It is also spatially distributed since the shear stresses are higher close to the vessel wall.
To calculate the anisotropic and flow-dependent electrical conductivity, Computational Fluid Dynamics (CFD) simulations are performed to model the flow field quantities. These quantities are then utilized in an analytical model that evaluates the conductivity of suspensions of ellipsoidal particles.
This shear-induced material property can be exploited to detect aortic pathologies, i.e. stenosis, aneurysm, or aortic dissection, by electrical impedance measurements at the body surface. Since the blood-filled aorta is much more conductive than the surrounding tissue, small variations in blood conductivity result in a divergent impedance curve in the course of a cardiac pulse wave. Both volumetric and conductivity changes contribute to the impedance changes, and their effects on the detection of abnormalities in the aorta are investigated by finite element simulations.

PLASTICITY OF FIBRIN NETWORKS: HUMAN VERSUS BOVINE

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Fibrinogen is a hexameric plasma protein composed of symmetrical halves, each composed of an Aα, Bβ, and γ subunit, which are held together at their N-termini at the center of the molecule by disulfide bonds. Although this general architecture is conserved among the species, species-specific differences in the chemistry of the subunits exist, which are transferred to the fibrin fibers to result in clots with different mechanical behaviors. In this study we chose the comparative approach to analyze the mechanical function of fibrin meshworks with stiffer or softer fibers. After describing their deformation under shear stress, we hope that assumptions can be made about the basic behavior of blood clots in patients whose fibrinogen chemistry is altered post-translationally or due to liver diseases. Human and bovine clots (coarse clots made of fibrinogen solution and citrated platelet depleted plasma) were first generated in the rheometer gap (CP50, 0.1mm gap width) by addition of homologous thrombin and calcium, and afterwards in-situ exposed to increasing shear stress amplitudes until the clot yielded (LAOStress protocol). Increasing the fibrinogen concentration (FIB) in the samples resulted in a prothrombotic state: the higher FIB, the faster the clot formed and the higher was G'. When these clots were cyclically loaded with increasing shear amplitudes at constant frequency (1Hz), the bovine systems started to deform plastically at lower shear stresses, stiffened more with shear, and required higher shear stresses to align the fibers in the shear direction. The higher FIB was, the higher was (1) G'_0 in LVER, (2) the shear stiffening response and (3) the threshold for switching from non-affine to affine deformation in both species and in both starting materials. Not only the fibrinogen concentration but also fibrinogen chemistry influences the clot behavior.

APPLICATION OF NARROW GAP RHEOMETRY IN BIOLOGY

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We modified commercial rotational rheometers to reach a parallelism of the plates of better than about ±1 µm. This is far below the effective zero-gap error of commercial rheometers, which is typically about 25 µm to 70 µm. This enables to study samples at gap widths of about 20 µm with the same accuracy as samples at 1 mm gap width in standard rheometers. This offers a number of advantages:

- Extension of the measurement window by 2 orders of magnitude to shear rates beyond 105 s-1
- Minimal amount of sample of the order of tens of µL
- Measuring low viscosities such as that of solvents, water or polymer solutions
- Besides extending the measurement range, the setup enables new applications, which are particularly relevant for biological systems:
- Detecting the viscoelastic properties of living cells. To this end, the cells are fixed to both rheometer disks in a monolayer. A single experimental runs is sufficient to determine average viscoelastic properties. The setup is particularly suited to access the linear viscoelastic range and to study the impact of pre-stress. As it determines the average storage and loss moduli, it allows quantifying, for instance, the impact of drugs on the cell mechanics.
- Adhesion limit of cells in low-viscous environments such as cell culture media can be determined
- Load limit of cells in low-viscous environments such as water or cell culture media can be determined.

The viscosity functions of buffered aqueous DNA solutions are now available across the whole shear-rate range, from the initial Newtonian plateau to that of infinite-shear viscosity.

APPLICATION OF MACRO- AND MICRORHEOLOGY FOR BIOLOGICAL FLUIDS

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Rheology of viscoelastic materials is considered to determine the amount of elastic and viscous properties for better understanding the behavior of certain materials. Nowadays this method is also used in the biological field. The flow behavior of materials can provide information about the amount of viscous or elastic molecular structure. According to different measuring types rheology can be divided into macro- and microrheology.
Macrorheology is an active operating method, referring to the measuring mode either the shear stress is kept constant and the shear rate is determined or vice versa. For small shear rates macrorheology provides valuable information.
Comparing to macrorheology, passive microrheology is a non-destructive method, using tracer particles which are driven by thermal energy (Brownian motion) which applies only minimal deformation to the estimated medium. This method is interesting for the biological field, due to the fact that the measuring process only needs some µl sample volume. Microrheology offers data in higher frequency range than macrorheology, therefore the data of both methods are complementary.
In our study, cerebrospinal fluid (CSF) from a patient after subarachnoid hemorrhage (SAH) was analyzed using macro- and microrheology at physiological body temperature (37 °C). The results were compared between these two methods and opposed with preliminary correlations between macrorheological and laboratory parameters of cerebrospinal fluid. These studies show, that there are relationships between certain disease pattern of patients, as well on the time elapsed since subarachnoid hemorrhage.

A THERMO-MECHANICAL PLATEFORM AVAILABLE AT THE LABORATOIRE LÉON BRILLOUIN

GASTON EXIL, LAURENCE NOIREZ
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The Saclay group has shown a couple of years ago, that it is possible to improve the measurement of the dynamic signal using high energy surfaces that provide a better wetting [1]. A finite shear elasticity was measured at submillimeter scale in fluids so far considered as purely viscous. A new homemade software has been recently elaborated to improve the measurement of the synchronous reading and visualization of several independent setups (shear strain, stress and normal force sensors with variable resolution time with an option to couple a thermal mapping) [2]. This instrumental coupling has successfully shown that mesoscopic liquids exhibit a change of temperature upon mechanical shear stress [3]. Such study is particularly important for physiological fluids examined in the frame of a collaboration with Medical University Vienna (U. Windberger) [4].
TMAnalysis is a dedicated real-time data acquisition and visualization system, combining camera and multimeters connected to the rheometer [4]. The programming language is Python, combined with EVOCORTEX's irDirectSDK programming API to drive microbolometers.
Keywords: Improved dynamic measurements, data acquisition and visualization.

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SPECIAL THANKS TO

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MICHAEL EDLER
Photography

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(Claude Bernard)

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