



## Synopsis: the 300th volume of colloid and polymer science

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With its 300th volume, *Colloid and Polymer Science* (CPS) looks back to a history of more than 110 years. The journal was founded in 1906 by the experimental physicist Wolfgang Ostwald, son of founder of Physical Chemistry, Wilhelm Ostwald, (Nobel prize in Chemistry 1909), and it was initially devoted to colloid science and later also to polymer science and their diverse interconnections. As early as 1916, Wolfgang Ostwald wrote the book “The World of Neglected Dimensions, An Introduction to Colloid Chemistry”, which was translated into English by Professor Martin H. Fisher in 1921. Articles on topics such as dispersion systems, friction, and adhesion in colloidal liquids have been published extensively at CPS. CPS also has a long list of authors for colloid and polymer researchers, including pioneers such as H. Staudinger (Nobel Prize in Chemistry 1956), W. Kuhn, G. Porod, E.W. Fischer, and P.G. de Gennes (Nobel Prize in Physics 1991).

To celebrate the 300th volume in 2022, we have collected a few representative articles that have appeared over the years. It is remarkable that most of the topics of CPS are still of high interest for academia and applied research. This emerges from a large number of overall, but also recent citations of some early articles. Many of these notable articles appeared in German — to make these articles more

accessible to international audiences, we collected short summaries in English below. We added other articles that we particularly enjoyed rereading, and together, they give an impression of the scientific topics published in CPS over the years. This collection adds to the one that was compiled at the occasion of the 100 anniversary in 2006 (<https://link.springer.com/article/10.1007/s00396-006-1520-9>). With this legacy, CPS looks forward to a most stimulating and bright future.

Abstracts of publications which appeared in *Colloid and Polymer Science* in its 300 volumes:

**Richard Lucas (1918), *Über das Zeitgesetz des kapillaren Aufstiegs von Flüssigkeiten. (On the time dependence of capillary suction of liquids)*.** Kolloid-Zeitschrift. 23(1), 15–22. <https://doi.org/10.1007/bf01461107>

This article focuses on the height of the liquid rising in the capillary, which is related to the surface tension and the mass density of the liquid as well as the radius of the capillary. The rate at which the liquid rises depends on time. The results of this study are consistent with the empirical equation found by Ostwald. Nowadays, the paper is of interest for understanding the imbibition in porous media, such as char and dry foams, the droplet evaporation on porous fabric materials and for microfluidics.

**Wolfgang Ostwald (1925), *Über die Geschwindigkeitsfunktion der Viskosität disperser Systeme. (On the velocity dependence of the viscosity in dispersions)*.** Kolloid-Zeitschrift 36, 99–117 (1925). <https://doi.org/10.1007/bf01431449>

The Hagen-Poiseuille law does not describe the viscosity of certain sols well. Furthermore, despite careful work, experimental results obtained with a Couette cell are not always reproducible. This article introduces the capillary viscometer and presents results from extensive measurements. It is suggested to use “structural viscosity” to describe deviation from the Hagen-Poiseuille law, which depends on pressure and flow rate. Simple equations for the retention time are suggested. This research has been

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frequently cited in drilling fluid studies, polymer processing and additive manufacturing.

**H. Staudinger (1932), *Über Isopren und Kautschuk. (About isoprene and natural rubber)*.** *Kolloid-Zeitschrift* 60, 296–298 (1932). <https://doi.org/10.1007/BF01429785>

The review article is related to a series of communications with the same topic, where the concept of macromolecules was introduced. It presents two main ideas: (1) The elastic properties of natural rubber are not caused by a double bond — as was assumed earlier — because hydrated natural rubber and other high molecular weight materials show elastic properties as well, albeit not quantitatively explored in limited high molecular weight materials. (2) Relations between the length of the polymers and the elasticity of the high molecular materials exist; however, quantitative relations have not been identified yet. This article, along with other articles published by Staudinger in 1920–30, is considered the cornerstone of modern macromolecule chemistry.

**B. Derjaguin (1934), *Untersuchungen über die Reibung und Adhäsion, IV. (Studies on friction and adhesion, IV)*.** *Kolloid-Zeitschrift* 69, 155–164 (1934). <https://doi.org/10.1007/bf01433225>

In this article, a theory of adhesion between solid particles is proposed, which takes into account molecular attractive forces in two cases: (i) the particles are not deformable, or (ii) the contact areas of the particles are deformed. For case (i), a general formula is deduced, according to which the adhesion force of convex bodies is proportional to the adhesion of the rescaled tear-off work of the flat surfaces. Taking into account the medium between the particles leads to repulsive forces caused by lyosorption. For case (ii), a modification of Hertz' formula is derived, that predicts that the adhesion force is independent of the contact area. This article is the original study of what came to be known as Derjaguin approximation, which is widely used to estimate forces between colloidal particles. The theory is also closely related with modern characterization techniques such as surface force apparatus, atomic force microscopy, as well as in colloidal aggregation.

**Werner Kuhn, F. Grün (1942), *Beziehungen zwischen elastischen Konstanten und Dehnungsdoppelbrechung hochelastischer Stoffe. (Relations between mechanical constants and birefringence in highly visco-elastic materials)*.** *Kolloid-Zeitschrift*, 101(3), 248–271. <https://doi.org/10.1007/BF01793684>

The angle distribution of linear molecular segments is calculated from the distance between the start and the endpoint of the molecule. At this case, the completely free Brownian motion of the segments is considered. The optical anisotropy of such a molecule is calculated from the anisotropy of the individual segment. For substances composed of

such molecules, the mechanical resistance to stretching as well as the optical anisotropy upon stretching are calculated, taking into account both the partial orientation of the segments and their length variation. The importance of these effects is different for elastic modulus and birefringence that occurs during stretching. The paper is currently cited in the fields of viscoelasticity of elastomers, polymer microgels, dielectric elastomers, orientation-dependent NMR, single-molecule force spectroscopy and the molecular orientation in organic optoelectronics.

**G. Porod (1952), *Die Röntgenkleinwinkelstreuung von dichtgepackten kolloiden Systemen. (Small angle x-ray scattering of densely packed colloidal systems)*.** *Kolloid-Zeitschrift*, 125(2), 51–57, 1952. <https://doi.org/10.1007/bf01519615>

The paper considers the small-angle X-ray scattering of densely packed colloidal systems with a focus on the interparticle interference. The invariant is introduced, which allows the calculation of absolute intensity, independent of the colloidal structure. Characteristic parameters for model-free description of the scattering from colloidal inhomogeneities are introduced. A discussion of the asymptotic dependence of the scattering intensity at high scattering angles showed that, if inherent interfaces exist, the scattering intensity decays with the -4th power of scattering angle. This expression is frequently used when fitting small-angle scattering data.

**M. Dettenmaier, E. W. Fischer & M. Stamm (1980), *Calculation of small-angle neutron scattering by macromolecules in the semicrystalline state*.** *Colloid and Polymer Science* 258, 343–349 (1980). <https://doi.org/10.1007/BF01466672>

The conformation of macromolecules in the semi-crystalline state has been studied by various authors with respect to the validity of the adjacent re-entry — or switchboard model by application of small-angle neutron scattering. Analytical as well as Monte-Carlo calculations show that the experimental results for melt-crystallized polyethylene and isotactic polypropylene can be interpreted on the basis of the solidification model. In this model, it is assumed that crystallization occurs by straightening of coil sequences without a long-range diffusion process.

**M. Ahlers, H. Ringsdorf, H. Rosemeyer & F. Seela (1990) “Orientation, recognition, and photoreaction of nucleolipids in model membranes”.** *Colloid and Polymer Science* 268, 132–142 (1990). <https://doi.org/10.1007/BF01513191>

Amphiphiles with nucleobases and nucleosides as head groups are synthesized, and their surface behavior is investigated in monolayers at the air/water interface. The double-chain nucleolipids form stable monolayers with nearly identical surface pressure-area diagrams, whereas the spreading behavior of the single-chain amphiphiles is dominated by the various nucleobase-head groups. When

measuring the interactions between nucleolipid monolayers and nucleobases (monomeric and polymeric ones), specific base effects are observed: The complementary nucleobases solubilized in the subphase expand the monolayer more than the non-complementary ones. Photo-dimerization reactions of thymine-amphiphiles are investigated in mono- and multilayers as well as in spin-coated films. This is a pioneering study demonstrating the importance of biofunctional amphiphiles in understanding the interactions between membranes and subphases, thereby advancing the development of chemotherapeutics.

**F. Brochard-Wyart, G. Debrégeas & P. G. de Gennes (1996), “Spreading of viscous droplets on a non viscous liquid”.**

Colloid and Polymer Science 274, 70–72 (1996). <https://doi.org/10.1007/BF00658911>

Some polymer melts (of high viscosity) can wet completely the surface of a non-miscible, simple liquid. The laws of spreading for a macroscopic droplet of this type are discussed for the case that the internal friction of the droplet dominates. We predict that the droplet radius increases with spreading time  $t$  like  $t^{1/4}$ , which corresponds to a droplet curvature decreasing like  $t^{-1}$ . The wetting of liquids is of utmost importance in microfluidics, electronic circuit printing and biochip fabrication.

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