

Polymer physics

Polymer physics is the field of physics associated to the study of polymers, their fluctuations, mechanical properties, as well as the kinetics of reactions involving degradation and polymerisation of polymers and monomers respectively.^[1]

While it focuses on an aspect of the study of condensed matter physics, the field of polymer physics has developed as a branch of statistical physics. Polymer physics and polymer chemistry are part of the wider field of polymer science.

Disordered polymers are too complex to be described using a deterministic method. However statistical approaches can yield results and are often pertinent since large polymers (that is to say, polymers which contain a large number of monomers) can be described efficiently as systems at the thermodynamic limit.

Thermal fluctuations continuously affect the shape of polymers in liquid solutions, and modelling their effect requires a recourse to the principles of statistical mechanics. As a corollary, temperature strongly affects the physical behaviour of polymers in solution.

The statistical approach to polymer physics is based on an analogy between a polymer and either a brownian motion, or some other type of random walk. The simplest possible polymer model is presented by the ideal chain, corresponding to a homogeneous random walk. Experimental approaches to Polymer physics are also common, using Polymer characterization methods such as size exclusion chromatography, Viscometry, Dynamic light scattering, and Automatic Continuous Online Monitoring of Polymerization Reactions (ACOMP)^{[2] [3]} to determine the chemical, physical, and material properties of polymers. These experimental methods lead to more accuracy in theoretical model formulation and hence allow better understanding of the polymer properties.

The Russian and Soviet schools of physics have been particularly active in the development of polymer physics.

Models

Models of polymer chains are split into two types: "ideal" models, and "real" models. Ideal chain models assume that there are no interactions between chain monomers. This assumption is valid for certain polymeric systems, where the positive and negative interactions between the monomer effectively cancel out. Ideal chain models provide a good starting point for investigation of more complex systems and are better suited for equations with more parameters.

Ideal Chains

The freely-jointed chain is the simplest model of a polymer. In this model, fixed length polymer segments are linearly connected, and all bond and torsion angles are equiprobable^[4]. The polymer can therefore be described by a simple random walk and ideal chain.

The freely-rotating chain improves the freely-jointed chain model by taking into account that polymer segments make a fixed angle to neighbouring units because of specific chemical bonding. Under this fixed angle the segments are still free to rotate and all torsion angles are equally likely.

The hindered rotation model assumes that the torsion angle is hindered by a potential energy. This makes the probability of each torsion angle proportional to a Boltzmann factor:

$$P(\theta) \propto \exp(-U(\theta)/kT)$$

In the rotational isomeric state model the allowed torsion angles are determined by the positions of the minima in the rotational potential energy. Bond lengths and bond angles are constant.

The Worm-like chain is a more complex model. It takes the persistence length into account. Polymers are not completely flexible; bending them requires energy. At the length scale below persistence length, the polymer behaves more or less like a rigid rod.

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Kathleen Armour



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Journal of Research of the National Bureau of Standards ,1965 *Technical News Bulletin of the National Bureau of Standards* United States. National Bureau of Standards,1968 **Papers Presented at the ... Meeting** American Chemical Society. Division of Polymer Chemistry,2000 Technical News Bulletin ,1970 **Index of Conference Proceedings Received** British Library. Document Supply Centre,1986 Indian Science Abstracts ,1996-04 **Journal of Research** United States. National Bureau of Standards,1963 **Dimensions** ,1963 **Technical News Bulletin** United States. National Bureau of Standards,1961 **Journal of Research of the National Bureau of Standards** United States. National Bureau of Standards,1967 **Recreational Boating** United States. Congress. House. Committee on Merchant Marine and Fisheries. Subcommittee on Coast Guard and Navigation,1986 Nanomaterials, Polymers and Devices E. S. W. Kong,2015-04-27 Providing an eclectic snapshot of the current state of the art and future implications of the field Nanomaterials Polymers and Devices Materials Functionalization and Device Fabrication presents topics grouped into three categorical focuses The synthesis mechanism and functionalization of nanomaterials such as carbon nanotubes graphene silica and quantum dots Various functional devices which properties and structures are tailored with emphasis on nanofabrication Among discussed are light emitting diodes nanophotonic nano optical and photovoltaic devices Nanoelectronic devices which include semiconductor nanotube and nanowire based electronics single walled carbon nanotube based nanoelectronics as well as thin film transistors **Papers and Addresses Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry** ,1979 Index of Conference Proceedings Received British Library. Lending Division,1988 **Miscellaneous Publication - National Bureau of Standards** United States. National Bureau of Standards,1934 **Index of Conference Proceedings** ,1994 *National Library of Medicine Current Catalog* National Library of Medicine (U.S.),1971 First multi year cumulation covers six years 1965 70 **Annual Report of the Council** Indian Institute of Science, Bangalore,1966 **Publications, July 1960 Through June 1966** United States. National Bureau of Standards,1967 □□□□□□□□□□□□□□□□□□□□ □□□□□□ (Japan),1972

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