



Thermodynamics of Polymer Solutions And Theor of Static Light Scattering Polymer Gels

Santosh Kumar ^{1*}, Dr. M. Z. Shahzada ²

1. Research Scholar, Deptt. of Chemistry, Magadh University, Bodhgaya, Bihar, India
santoshnwd8384@gmail.com,

2. Associate Prof. & Head, Dept. of Chemistry, K.L.S. College, Nawada, M.U., Bodhgaya, Bihar, India

Abstract: The study deals with “Thermodynamics of polymer solutions and theory of static light scattering polymer Gels.” The research interests include “thermodynamics of polymer solutions and static light scattering theory of polymer gels”, there are many types of changes in physical gels (our model is gelatin gel) and the relationships they follow. We solved the problem of the formation of spikes in gelatin gels. All these are studied by different experiments such as Differential Scanning Calorimetry (DSC), Dynamic Light Scattering (DLS), Static Light Scattering (SLS), Dielectric Relaxation Measurements, Optical Rotametry, Viscometer, Density determination, refractive index measurement and conductivity measurement. We propose another theory for quantitative analysis in order to obtain parameters such as polydispersity, weight average molecular weight, Mark-Howick index and other properties of molecular weight polymers from DLS data. Polymers have always been considered a strong area by chemists, especially organic chemists, but recently (in the last few years) it has become more of a collaborative effort rather than a discipline-specific fir It is a mix of chemists, physicists, biologists, etc.

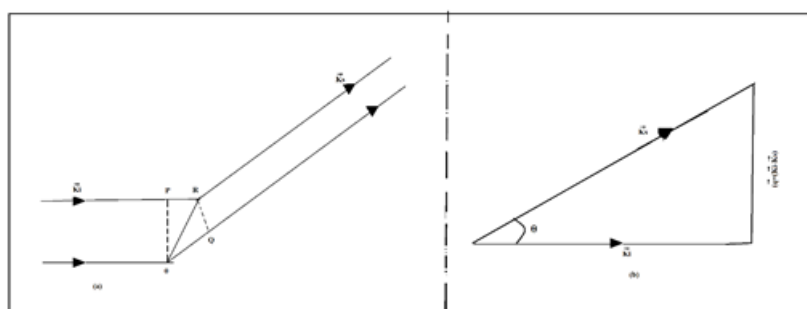
Keywords: Differential Scanning Calorimetry, Dynamic Light Scattering, Static and Light Scattering

----- X -----

INTRODUCTION

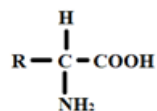
Light scattering is a very powerful technique for studying the physical properties that's patterns and structures of systems (especially solutions). Among the many advantages of this procedure, the most important is that it is a non-invasive procedure, provided that the intensity is not high enough to ionize the system. The scattering that occurs due to the change in the incident and scattering energy can be called elastic scattering (Rayleigh scattering), quasi-elastic scattering (Rayleigh-Brillouin scattering), or inelastic scattering (Raman scattering). Elastic light scattering includes static light scattering (SLS) and dynamic light scattering (DLS).¹ The combination of the two provides a powerful tool for studying the entire anatomy of the body. In static light scattering, information about the physical properties of macromolecules (such as molecular weight, radius of gyration, second virial coefficient of interparticle and intraparticle interaction, etc.) is included in the angular dependence of the reference. In contrast, “dynamic light scattering” shows the properties of macromolecules in different thermodynamic and hydrodynamic environments (diffusion coefficient, hydrodynamic radius, etc.).² It has long been known that any excitation that changes the measurement of the condensed medium results in a burst of light. A perfectly homogeneous crystal will diffract without light in all directions except the forward direction.³ This is because in a perfectly ordered crystal, light scattered from the lattice points will cause damage, so the intensity is so low that it does not matter. So, this means that the interference damage must fail to achieve a constant power. But in reality, an object has a finite heat content at any given time, it creates a finite

scattering intensity. From the above discussion, it is clear that light is refracted only when there is a change in the reflection region with a change in the reflection index, for example $(8p/8c) - o$.⁴ Discuss the silent properties of efflorescence. In a typical experiment, light is scattered by the polymer solution, and the detector is placed at an angle “0” to the direction of light propagation. -+⁵ The physical body of the incident light is characterized by the wave vector K of frequency ω and the polarization state $[P, l]$ and the corresponding parameter w' describing the light scattering K .⁶ and $[P, l]$. In an experimental explosion, large changes in the energy, force and state of polarization of matter occur. But since we are only interested in quasi-elastic scattering of light, we can safely assume that the electron scattering $E_s (= \hbar\omega_s)$ is almost the same as the incident energy E , ($= \hbar\omega$), and hence the amplitude of the corresponding wave vector is almost equal to $- + - +$, i.e. $|K| + |K|$.⁷

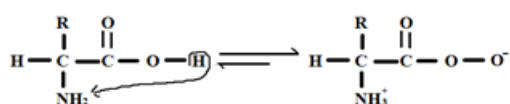


A medium with a refractive index of “ n ”. Because we have already proven, in a semi-elliptical light scattering experiment, that one of many means of influencing the secondary structure of collagen and in many cases some aspects of the primary structure can be written for collagen. and tertiary. model. This can only be done by chemical treatment and heat treatment. For this reason it is sometimes also called denatured or indeterminate collagen. They are the main stress-bearing cells of all animals and fish. Collagen makes up 30% of all organic matter in animals and 60% of all protein content. Most collagen is found in large tissues such as skin, bone, and tendon, but collagen fibers are found in almost every organ and tissue. Because of their wide distribution and function, fibers in different tissues are macroscopically formed in different ways, produced by different cell types, and associated with different drugs and even more doses of drugs. There are many ways to convert collagen into gelatin. Therefore, it is not surprising that gelatin with different properties and characteristics is obtained from different collagens by different methods. In fact, we obtain gelatins with different properties and characteristics. Since it is used mainly in food (salads, desserts, bakery products, etc.), in the pharmaceutical industry and in cosmetics. Although this is still true, recently we have focused on gelatin, understanding the essential oil of the main collagen, its properties. Gelatin is also unique among all proteins in its lack of “internal order”.⁸ Therefore, in aqueous solutions at sufficient temperature, the peptide chains adopt random configurations. This is similar to the behavior of synthetic linear polymers. This therefore allows us to study the structure and behavior of gelatin from the perspective of a polymeric system. Another area of research that has received considerable attention in recent years is the sol-gel transition in gelatin gels. From here we can obtain information about the uncertainty of the phase change that occurs at the gelation point, the properties of the gel body, the scaling relationships, etc. It is also a protein, so it is worth saying a few words about the protein. Most of the things that allow organisms to live are very similar. There are only a few elements, and their ratio is

547. Carbon, 77. Hydrogen, 167. Nitrogen, 227, oxygen, and 17, sulfur.⁹ They are apparently so important to the structure and chemistry of living organisms that they are called proteins. A protein is a linear chain with its own backbone. A series of amino acid monomers having the following composition:



Among them, COOH is the carboxyl group, NH₂ is the amine group, and “R” is the side group (free radical) of the amino acid. In addition to “C” and “H” (hydrocarbons), “R” also has other atoms such as “O”, “S”, “N”, etc. On the group side. When R = H, the smallest and simplest is glycine. Under normal physiological conditions, amino acids exist in doubly ionized form. In this case, the acidic carboxyl group loses a proton and the basic amino group gains a proton, forming a dipolar or zwitterion:

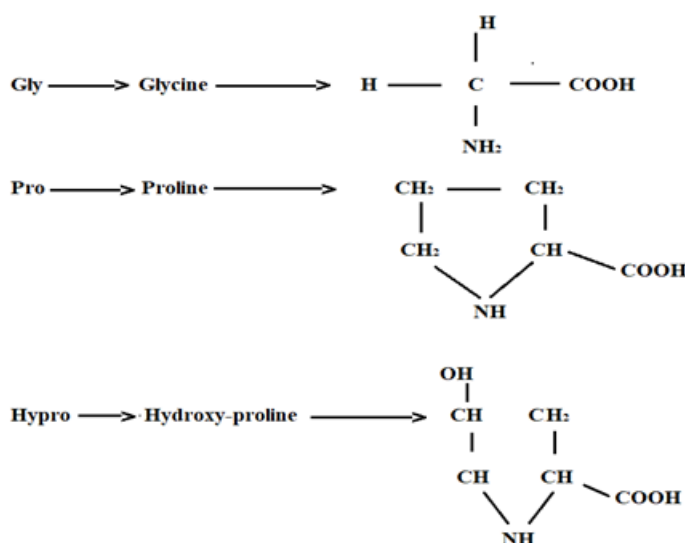


Having atomic groupings of both kinds, they exhibit properties of both carboxylic acids and amines.¹⁰

Chemical Composition of a collagen:

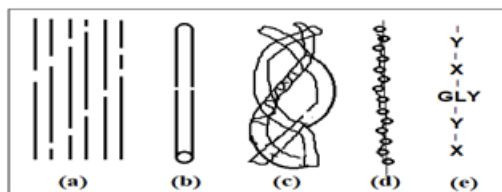
Collagen is unique among proteins due to its amino acid composition. It is the only animal protein with a significant hydroxyproline content and less rich in glycine and proline. Hydroxyproline is almost a unique collagen product. Collagen has a very low sulfur content. In collagen, there is one glycine residue for every three elements (337.). The amino acids proline and hydroxyproline residues are found in large numbers in collagen (257 in total). As we mentioned above, although the chemical composition of collagen is not unique, its structure is: — (Gly — Pro — X) — OR — (Gly — X — Hypro) —

Where ‘X’ being different amino acids.

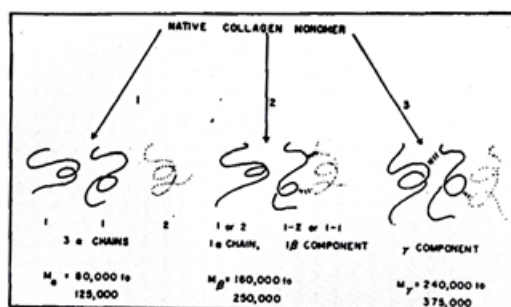


The presence of rings in proline and hydroxyproline increases the local rigidity of the chain. The amino acid groups also play an important role in protein stability. Some have polar groups (OH, CO, NH₂, etc.) that can interact with water molecules and form hydrogen bonds. There are also different numbers of polar charged groups (NH, COO⁻, etc.). The ratio of charged to uncharged groups changes with pH; for example, the NH group can be either NH or NH⁺. Charged groups are also hydrophilic. Hydrophobic groups (such as proline) are also encountered. Thus, the conformation that a protein assumes when dissolved in a solution (usually an aqueous solution) is a direct result of the balance of hydrophilic and hydrophobic interactions, which in turn is due to the composition of the molecule.

The total length of the collagen chain is 1000 residues (primary structure). Each chain is coiled into a left-handed helix with 10 residues every 3 turns. The helix spacing is approximately 0.9 nm. The rotation of the chain is such that the (C=O) and (N-H) groups attached to the backbone are oriented perpendicular to its axis and are not in a position to form intrachain hydrogen bonds to stabilize the helix. So the question is: Is there another way to improve the spiral? The answer for collagen is the triple helix. The three strands are wound into a super right-handed helix with a spacing of approximately 10 times longer (3.6 nm). The presence of the “Gly” brings the three chains closer together, while the “Pro” and “Hypro” residues increase rigidity. Each chain gradually turns to the right, allowing groups of different sizes to enter the structure. Hydrogen bonds can be of different types, either direct (e = 0) and (N-H) between two adjacent bones or through water molecules in an intermediate position in the triple helix. The total length of the triple helix is about 300 nm. The rods are arranged in rows to form fibers that connect to additional rows at each end of the rods. These bonds make the collagen fibers insoluble. The molecular structure of collagen at different levels is as follows:



Collagen to Gelatin Transition- Collagen is extracted from tissue by chemicals (acidic or alkaline) and thermal treatments. The main purpose is to break the covalent bonds between the rods and separate the individual chains. This process also disrupts the hydrogen bonds that hold the triple helix together, resulting in a triple helix. Unwanted minerals or organic matter are also removed in this process. The resulting product from all these processes is gelatin. The transformation of collagen to gelatin is sharp and is completed in a short time within minutes. The activation energy of denaturation is ~ 81 Kcal and the activation energy is $+ 230$ e.u.



Schematic diagram of the traditional structure of monomeric collagen with different types of gelatin, showing that there is no breakage of peptide bonds.

Without additional limiting bonds between the chains (Way-1), randomly coiled single-chain peptide chains appear. The three strands can have different sizes and have different molecular weights. These chains are called alpha chains. In the second (way 2), two chains are connected to each other by one or more covalent cross-links. In this case, denaturation occurs in such a way that two chains appear; The “beta” component may consist of two identical or different alpha chains. The weight distribution will be 67% β and 33%. In the last case (path 3), at least two covalent cross-links hold the three chains together. The conflict is gone. All the lines of secondary structure are present, but the three chains are still in solution as a unit. This triple-stranded structure is called the “ β ” component. Therefore, the number average molecular weight of the gelatin system should be one-third the molecular weight of the collagen monomer, with the average molecular weight being slightly higher due to the difference between the chains. The ideal value for collagen monomer molecular weight is well over 300,000 daltons. Therefore, the minimum weight of the parent ear should be above 100,000 daltons.¹¹ In any case, the minimum and maximum should be above 100,000 in cases where intramolecular aggregation is important.

CONCLUSION

This work tests the “thermodynamics of polymer solutions and the static light scattering theory of polymer gels”. The gradual transition of gelatin gel from sol state to gel state is mapped in a full conformational manner by using different experiments such as differential scanning calorimetry (DSC), dielectric relaxation, static light scattering (SLS) and dynamic light scattering (DLS), optical rotation, viscometer, density determination, RIM measurement and electrical conductivity measurement (ECM). In this method, we evaluated the spinodal lines in gelatin gels by diffraction test and evaluated the results using the Tanaka mean response method. In addition, we also used the dynamic light scattering theory to determine the intrinsic polydispersity and molecular weight distribution of high molecular weight polymers. Perform the experiment. Our sample systems are: polystyrene cyclohexane (8-0 wt) at 35°C, polystyrene toluene (good solvent) at 20°C and latex beads (third sphere) in neutral deionized water. Experiments This provides good competition for the results. It was obtained from the analysis of DLS data. The gel transfer temperature T_{gel} was obtained by various tests such as DSC, dielectric relaxation test, light scattering test and optical test. The T_{gel} values obtained from these experiments are very similar except for the optical rotation measurements where the T_{gel} evaluation is not possible for many users. In the DSC data, at least two additional moments can be observed in the sol field content before the gelation starts ($T > T_{gel}$). These two temperature changes consist of T₂ and T₃. The two transition temperatures T₃ and T₂ correspond to 0: the formation of monomers into aggregates and the transition from random helices to single helices (destructive transition). Electron conduction measurements confirmed the T₃' transition temperature, the transition from monomer to aggregate, but could not resolve the transition from random coil to single coil. This may be because the light scattering test was not sufficient and could not see a helix.

References

1. Sants. P.T. and Tanford, C., (2015) In Physical Chemistry of Macromolecules on gelation, (7thEd.) John

Wiley & Sons, Inc.

2. Max .G.G. and Billmayer, F.W., (2016), In Reduced Science ‘Text Book of Polymer Science, (9th Ed.) Wiley-Interscience Publication, NJ.
3. Lic. L.C. and Smoluchowski, M. V., (2017) Know the Phys. Z., 17, 557.
4. Argon, S.R. and Pecora, R., J. (1997), Chem. Phys., 64, 2395.
5. Jossang, T., Feder, J. and Rosenvist, (1985), E., J. Chem. Phys., 82, 574.
6. Kite, O. & Russo, P.S. (Ed.), (2015) In New Era; ‘Reversible Polymeric Gels and related Systems’ ACS Symposium Series, II-5(I) 8796.
7. Ornstein, L.S. and Zernike, F., Proc. (2013), Acd. Am. Sci.. Amsterdam. 17, 793, (Reviewed).
8. Koppel, D.E., J. Chem. (1972) Phys. 57, 4814.
9. Yamakawa, H., (2014) In “Modern Theory of Polymer Solutions” (Harper and Row, (Reviewed).
10. Tanaka, T., Ishiwata, S. and Ishimoto, C., (1977), Phys. Rev. Lett, 38, 771.
11. Boedtkar, H. and Doty, P., J. (1995), Phys. Chem. 58, 968.