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***Journal of Scientific and Engineering Research*, 2017, 4(8):288-300**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Engineering and Innovative Processes and Techniques for the Conservation of Cultural Heritage

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Abstract In this paper, engineering and innovative processes and techniques for the conservation of cultural heritage are presented. In particular, the ancient artifacts are coated with polymeric mixtures diluted in water, treated by acoustic levitation, displayed on a FT-IR microscope, heated in a specific glass bell and lastly analyzed by InfraRed (IR) spectroscopy. On one side, the innovation of the acoustic levitation permits a better penetration of the polymeric solution during the treatment of the sample, on the other to follow the polymeric drying process in the function of time. Furthermore, IR spectroscopy technique is employed to understand what is happening inside the artifact and to evaluate the thermal response. This new engineering approach for the conservation and preservation of cultural heritage has been shown to be rather valid and has been reported an application example on wood.

Keywords Acoustic Levitation, InfraRed Spectroscopy, Polymeric Mixtures, Cultural Heritage Conservation.

Introduction

Nowadays, different interdisciplinary studies, processes and innovative techniques are more and more employed to conserve and preserve ancient artifacts belonging to the cultural heritage. In the specific case of wooden artifacts, such as dry wood (sculptures and paintings on wooden panels) or wet wood (e.g. archaeological wood), the physical, chemical and biological effects due to time passes cause the degradation of their technical and decorative features. Therefore, it is understandable, as without appropriate processes and techniques of conservation, protection and preservation, all these findings will meet the ruin until to an irreversible destruction, also caused by the high degree of wood tissue degradation because of the wood destroying fungi and bacteria.

Wooden cultural heritage is an inexhaustible source of information for both historians and researchers of the past, in fact it constitute material evidence of history, so, it is of paramount importance to develop new methods for historic wooden artifact conservation with a wide range of applicability.

Wooden artifacts conservation is an highly complex matter on the borderline of aesthetic, art and science, it is necessary sustaining the physical integrity while retaining the authenticity of findings. In this context, the development of safe and effective methods for cultural heritage conservation is extremely important to provide and to transfer historical knowledge to future generations. The purpose of such research is to develop innovative processes and techniques for wooden findings conservation and preservation.

Since the 1950s, artificial resins have been employed to strengthen and to consolidate the damaged wooden artifacts. If on one hand, they present a large number of advantages, on the other hand, with the passing of time, they exhibit a lot of serious disadvantages, in fact they take way some wood components, that negatively

changes the wood characteristics, weaken the wood structure and make it fragile and very susceptible to destruction. Furthermore, they cause the discoloration and damageof the finishing layers.
Mostly synthetic polymeric solutions are recently employed in archaeological wooden findings conservation and preservation as to strengthen the degraded wood tissue. They penetrate thoroughly into the internal structure of the wood, displacing the natural moisture in the microscopic and lattice like structure of the woo fiber walls by diffusion of the large molecules of the chemical.
It also important to develop innovative techniques to the wood treatment. In this context, acoustic levitation is employed to raise the penetration of the polymeric solution and to follow the polymeric drying process in the function of time.
There are many levitation techniques [1], that can be used to suspend a sample in air, e.g. optical [2,3], electro-magnetic [4–7], electrostatic [8–10], gas-film [11,12], aerodynamic[13–27] and acoustic levitation [28–49].Among these quotes, the last one permits to analyze the hydrogen-bonded systems of biophysical interest, for example aqueous solutions[50–56], disaccharides [57–74], proteins [75–78], polymers [79–127] and polyols [128–134]. For these systems, is extremely important to address the experimental studies to the whole concentration range, starting from highly diluted to highly concentrated solutions. So far a significant experimental material has been accumulated on the properties of polymer solutions diluted in water [81-120], obtained by inelastic light diffusion [53], incoherent neutron dispersion [135–139] etc.
In this paper, engineering and innovative processes and techniques for the conservation of cultural heritage are presented. In particular, the ancient artifacts were coated with polymeric substances diluted in water, treated by acoustic levitation, displayed on a FT-IR microscope, heated in a specific glass bell and lastly analyzed by InfraRed (IR) spectroscopy. By means of IR spectroscopy it is possible to understand what is happening inside the polymerized treated artifact and to evaluate the thermal response. This new engineering approach for the conservation and preservation of cultural heritage has been shown to be rather valid and has been reported an application example on wood.

Materials and Methods

The main purpose of the paper is to develop innovative, original and effective processes and techniques for the conservation of cultural heritage, in particular, historic wooden artifacts, that are very difficult and complicated issue. Therefore all the tasks and methods within the paper were designed and developed to undertake multiple research and activity contributing to reach the envisaged purpose step by step. In this context, engineering and innovative processes and techniques for the conservation of cultural heritage were developed and in figure 1 summarized.

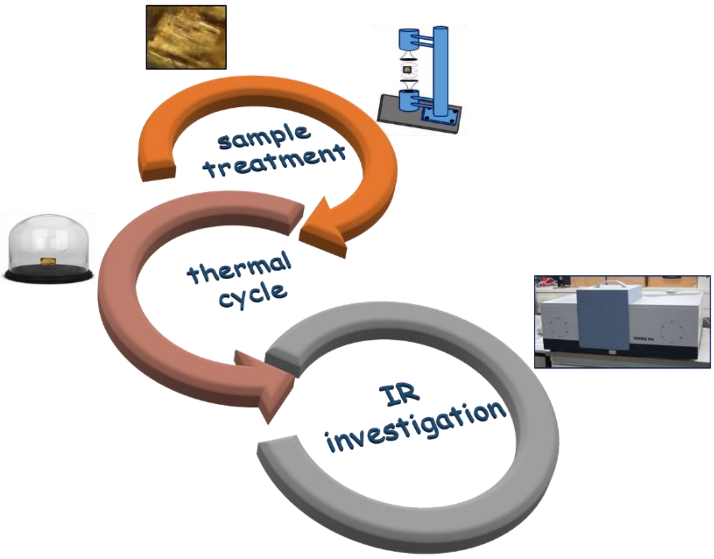


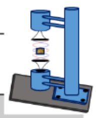
Figure 1: Engineering and innovative step for the conservation of cultural heritage

The first step is the sample treatment: after a bath in the polymeric solution for the sample preparation, the artifact is treated, levitating by means of an acoustic levitator [42]. The action of the levitation guarantees a new approach for sample preparation allowing to obtain high concentrated mixtures starting from highly diluted polymeric solutions diluted in water and to increase the polymer solution penetration within the wood matrix. At the same time, it permits to follow the polymeric drying process as a function of time. The levitation forces that determine the sample shape can be divided into axial forces, main responsible for compensating the gravitational force and radial forces that hold the sample in the pressure node.

The main part of the levitation device is formed by two transducers (or, in general, by an only transducer and a reflector), arranged on a rigid vertical axis of a diameter of 38 mm, in opposite position with a distance of 15 cm, generating two acoustic waves of 22 kHz. These sinusoidal waves produce pressure gradients and interferences that permit the sample levitation in the nodes, which form in the waves. Furthermore, two acoustic absorbing foam disks of a diameter of 50 mm are installed above the transducers to reduce unwanted reflections that cause instabilities in the levitated samples. A capacitive load, varying with the frequency, is represented by an ultrasonic power amplifier, powered by a power supply, formed by a push-pull amplifier and a matching transformer and the power output transistors, powered from a ±40 V rail. The drive signal is send by an acoustic controller circuit that hooks the resonant frequency of the transducers with a phase lock loop and maintains near zero the phase angle between the drive current and the voltage. It also have other important functions, for example, it can enable the control of the drive power, or the relative phase between the transducers, can balance the drive power to the transducers and can modulate the acoustic power.

An oscilloscope guarantees the current circulation within the transducer. The sample is levitated for 40 minutes and can be translated by adjusting the phase between the transducers or squeezed by modulating the acoustic levels with variable frequencies. It is monitored by an infrared video camera, mounted near the sample in levitation, recording video and image that save in a Tough book PC. The table 1 reports the main characteristics of the single axis acoustic levitator. It is rather light (30 Kg) and of small dimensions (30 x 45 x 60 cm), the nominal resonant frequency of the transducer is of 22 kHz, the sound pressure levels of 160 dB and the distance between the two transducers of 150 mm.

Table 1



Single-axis Acoustic Levitator (SAL)	
Frame and levitator system dimensions	30 x 45 x 60 cm
Controller dimensions	60 x 45 x 20 cm
Total weight	30 Kg
Electrical specifications	100/120V 60 Hz, 15A 230 V 50/60 Hz, 15A
Nominal resonant frequency	22 kHz
Sound pressure levels	160 dB
Transducers distance	150 mm

Table 1. Single-axis Acoustic Levitator (SAL) characteristics. The device is rather light (30 Kg) and of small dimensions (30 x 45 x 60 cm), the nominal resonant frequency of the transducer is of 22 kHz, the sound pressure levels of 160 dB and the distance between the two transducers of 150 mm.

The second step is the sample heating, through a specific glass bell in order to make a thermal cycle from to room temperature (20°C) to 350°C, temperature at which the sample burns. After each sample heating, the third step happens: an IR spectrometer is employed to analyze the treated sample and in the specific case, to understand what is happening inside the artifact and to evaluate the thermal response. FTIR Vertex 70 v spectrometer produced by Bruker Optics, used to make an off line collection of the absorption spectra, with a resolution of 4 cm^{-1} and 128 interferograms for each spectrum. The software OPUS was employed to process data and the spectra corrections for atmospheric water background, baseline and area normalization were carried out. Figure 2 shows the internal scheme of the spectrometer.

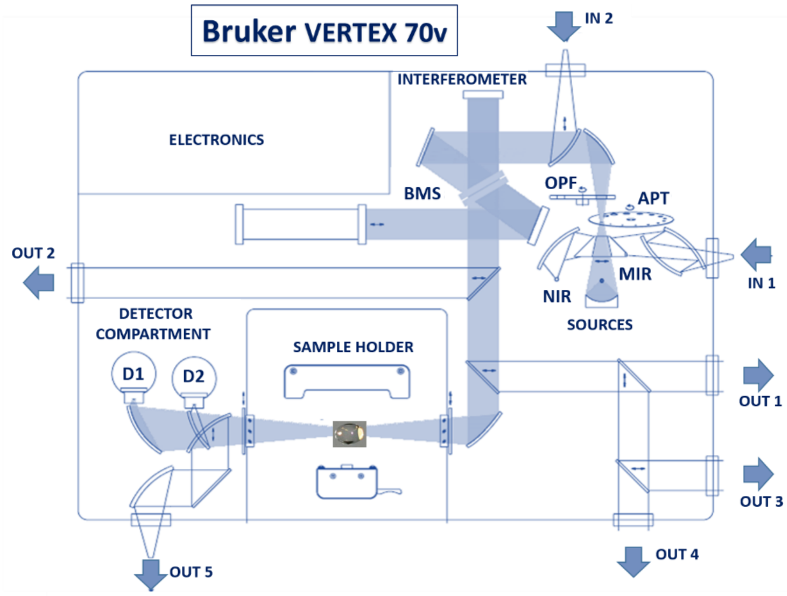


Figure 2: Internal scheme of Bruker VERTEX 70v IR spectrometer

Results and Discussion

The results obtained for acoustically levitated polymeric aqueous solution at atmospheric pressure, used for the treatment of the ancient wooden artifacts and those obtained for the levitated and heated wooden samples with the respective analysis are reported.

In particular, the figure 3 reports the IR spectra of levitated polymeric aqueous solutions at T=25°C for the concentration values ϕ = 0.50 as a function of time, i.e. 0 min, 5 min, 15 min, 30 min and 45 min.

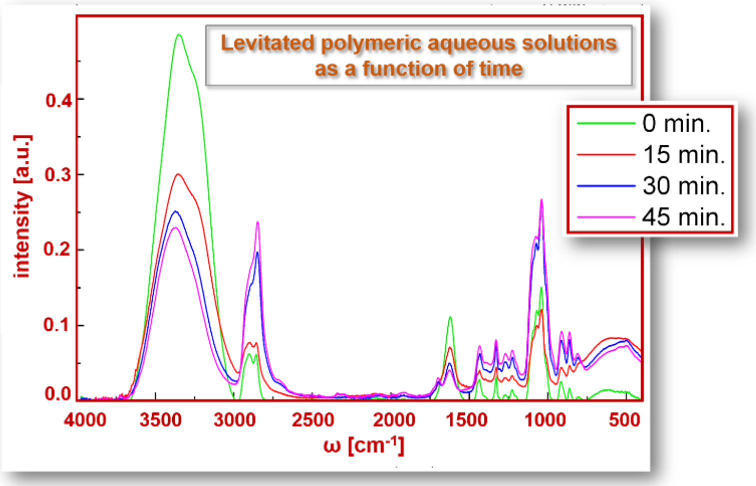
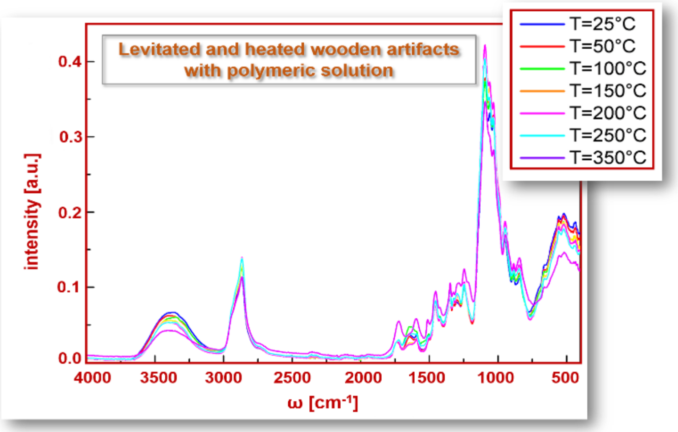


Figure 3: IR spectra of acoustically levitated polymeric aqueous solutions as a function of time (0, 15, 30 and 45 minutes)

The mid-infrared spectrum can be divided into four regions between 4000 and 400 cm^{-1}:

- 4000÷2500 cm^{-1}= X–H stretching region;
- 2500÷2000 cm^{-1}= the triple-bond region;
- 2000÷1500 cm^{-1}=the double-bond region;
- 1500÷400 cm^{-1} = the fingerprint region.

In this paper, the X-H stretching region was explored for polymeric aqueous solutions and has been reported that at concentrations range of 50%, focusing the attention on O-H/C-H stretching.
The X–H stretching region is characterized by fundamental vibrations, usually due to O–H, N–H and C–H stretching. O-H stretching produces a broad band that occurs between 3700 and 3600 cm^{-1}, N-H stretching is generally observed in the range 3400÷3300 cm^{-1}. This absorption is generally much sharper than O–H stretching and may, therefore, be differentiated. The C–H stretching bands from aliphatic compounds occur in the range 3000–2850 cm^{-1}. If the C–H bond is adjacent to a double bond or aromatic ring, the C–H stretching wavenumber increases and absorbs between 3100 and 3000 cm^{-1}.
From the IR spectrum is possible to see like the polymeric solution lost water as a function of time.
Figure 4, on the left, shows the IR spectra of wooden samples treated with acoustically levitated polymeric solutions diluted in water and heated at different temperatures, i.e. 25, 50, 100, 150, 200, 250 and 350°C and Figure 5, on the right, reports the ratio of the OH/CH area as a function of the temperature, from to the room temperature (25°C) to 350°C.



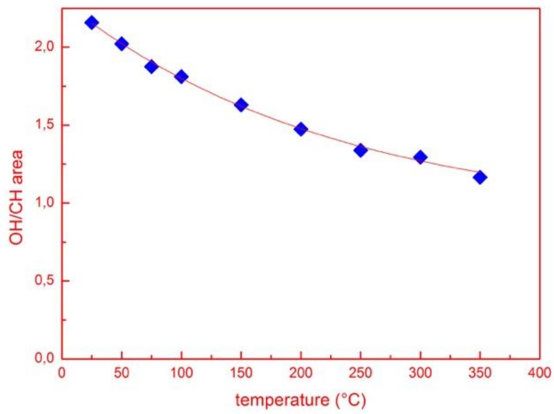


Figure 4: On the left, IR spectra of wooden samples treated with acoustically levitated polymeric solutions diluted in water and heated at different temperatures (25, 50, 100, 150, 200, 250 and 350°C); on the right, the ratio of OH/CH area as a function of the temperature

From this analysis emerges that the ratio of OH/CH contribution decreases at the increasing of the temperature until to reach a plateau about 350°C. This finding suggests that the treatment with PEG allows a major thermal response.

Conclusion

In conclusion, this paper, engineering and innovative processes and techniques for the conservation of cultural heritage were presented. In particular, the ancient artifacts have been coated with polymeric mixtures diluted in water, treated by acoustic levitation, displayed on a FT-IR microscope, heated in a specific glass bell and lastly analyzed by IR spectroscopy.

An applicative example on an ancient wooden artifact was reported. It is shown as, with the acoustic levitation the polymeric solutions penetrate at the bottom of the wood matrix. The main idea behind the innovative solutions is based on technology using acoustically levitated polymeric solutions, integrated in the wood. This new engineering approach for the conservation and preservation of cultural heritage has been shown to be rather valid, that will therefore enable wooden historic findings to keep their shape and spatial form.

References

[1]. Cuello, G. J., Cristiglio, V., Hennet, L., P.O. I. (2014). Neutron Scattering at High Temperature and Levitation Techniques. Journal of Physics: Conference Series, 549.

[2]. Ashkin, A., Dziedzic, J. M., Bjorkholm, J. E., & Chu, S. (1986). Observation of a Single-Beam Gradient Force Optical Trap for Dielectric Particles. Optics Letters, 11(5), 288.

[3]. Neuman, K. C., & Block, S. M. (2004). Optical Trapping. Rev Sci Instrum, 75(9), 2787–2809.

[4]. Muck, O. (1923). ElectroMagnetic Levitation.

[5]. Jacobs, G., Egry, I., Maier, K., Platzek, D., Reske, J., & Frahm, R. (1996). Extended X-Ray-Absorption Fine Structure Studies of Levitated Undercooled Metallic Melts. Review of Scientific Instruments, 67(10), 3683.

[6]. Egry, I., Diefenbach, A., Dreier, W., & Piller, J. (2001). Containerless Processing in Space - Thermophysical Property Measurements Using Electromagnetic Levitation. International Journal of Thermophysics, 22, 569-578–578.

[7]. Holland-Moritz, D., Schenk, T., Convert, P., Hansen, T., & Herlach, D. M. (2005). Electromagnetic Levitation Apparatus for Diffraction Investigations on the Short-Range Order of Undercooled Metallic Melts. Measurement Science and Technology, 16, 372–380.

[8]. Rhim, W. K., Chung, S. K., Barber, D., Man, K. F., Gutt, G., Rulison, A., & Spjut, R. E. (1993). An Electrostatic Levitator for High-Temperature Containerless Materials Processing in 1-G. Review of Scientific Instruments, 64(10), 2961–2970.

[9]. Paradis, P. F., Ishikawa, T., Yu, J., & Yoda, S. (2001). Hybrid Electrostatic-Aerodynamic Levitation Furnace for the High-Temperature Processing of Oxide Materials on the Ground. Review of Scientific Instruments, 72(6), 2811–2815.

[10]. Gangopadhyay, A. K., Lee, G. W., Kelton, K. F., Rogers, J. R., Goldman, A. I., Robinson, D. S., Rathz,T.J., & Hyers, R. W. (2005). Beamline Electrostatic Levitator for In Situ High Energy X-Ray Diffraction Studies of Levitated Solids and Liquids. Review of Scientific Instruments, 76(7).

[11]. Granier, J., Potard, C. (1987). Elaboration et Moulage Sans Conteneur par la Methode Dp.S Films de Gaz Demonstration et Modelisation Preliminaires. 6th European Symposium Microgravity. Bordeaux, France, ESA SP-256, 421–25.

[12]. Parayre, C., Daniel, M., Papoular, M., & Kernevez, N. (1999). High-Temperature Containerless Viscosity. International Journal of Thermophysics, 20(4), 1071–1083.

[13]. Nordine, P. C., Atkins, R. M. (1982). Aerodynamic Levitation of Laser-Heated Solids in Gas Jets. Review Scientific Instruments, 53, 1456.

[14]. Drewitt, J. W. E., Hennet, L., Zeidler, A., Jahn, S., Salmon, P. S., Neuville, D. R., & Fischer, H. E. (2012). Structural Transformations on Vitrification in the Fragile Glass-Forming System $CaAl_2O_4$. Physical Review Letters, 109(23).

[15]. Kozaily, J., Hennet, L., Fischer, H.E., Koza, M., Brassamin, S., Magazù, S., Kargl, F. (2011). Time-of-Flight Neutron Spectroscopy: A New Application of Aerodynamic Sample Levitation. Physica Status Solidi (C) Current Topics in Solid State Physics, 8, 3155–3158.

[16]. Hennet, L., Cristiglio, V., Kozaily, J., Pozdnyakova, I., Fischer, H.E., Bytchkov, A., Drewitt, J.W.E., Leydier, M., Thiaudière, D., Gruner, S., Brassamin, S., Zanghi, D., Cuello, G.J., Koza, M., Magazù, S., Greaves, G.N., Price, D. L. (2011). Aerodynamic Levitation and Laser Heating: Applications at Synchrotron and Neutron Sources. European Physical Journal: Special Topics, 196, 151–165.

[17]. Hennet, L., Pozdnyakova, I., Bytchkov, A., Cristiglio, V., Zanghi, D., Brassamin, S., Brun, J.F., Leydier, M., Price, D. L. (2008). Fast X-Ray Scattering Measurements on High Temperature Levitated Liquids. Journal of Non-Crystalline Solids, 354(47–51), 5104–5107.

[18]. Hennet, L., Pozdnyakova, I., Cristiglio, V., Cuello, G. J., Jahn, S., Krishnan, S., Saboungi, M.L., Price, D. L. (2007). Short and Intermediate-Range Order in Levitated Liquid Aluminates. Journal of Physics: Condensed Matter, 19(45), 455210.

[19]. Hennet, L., Krishnan, S., Pozdnyakova, I., Cristiglio, V., Cuello, G. J., Fischer, H. E., Bytchkov, A., Albergamo, F., Zanghi, D., Brun, J. F., Brassamin, S., Saboungi, M. L., Price, D. L. (2007). Structure and Dynamics of Levitated Liquid Materials. Pure and Applied Chemistry, 79, 1643–1652.

[20]. Cristiglio, V., Hennet, L., Cuello, G. J., Pozdnyakova, I., Bytchkov, A., Palleau, P., Fischer, H.E., Zanghi, D., Saboungi, M.L.,Price, D. L. (2007). Structural Study of Levitated Liquid Y_2O_3 Using Neutron Scattering. Journal of Non-Crystalline Solids, 353(8–10), 993–995.

[21]. Hennet, L., Pozdnyakova, I., Cristiglio, V., Krishnan, S., Bytchkov, A., Albergamo, F., Cuello, G.J., Brun, J.F., Fischer, H.E., Zanghi, D., Brassamin, S., Saboungi, M.L., Price, D. L. (2007). Structure and Dynamics of Levitated Liquid Aluminates. Journal of Non-Crystalline Solids, 353(18–21), 1705–1712.

[22]. Mathiak, G., Brillo, J., Egry, I., Pozdnyakova, I., Hennet, L., Zanghi, D., Bytchkov, A., Price, D.L.,Thiaudiere, D. (2006). Versatile Levitation Facility for Structural Investigations of Liquid Metals. Microgravity Science and Technology, 18(3–4), 67–72.

[23]. Hennet, L., Pozdnyakova, I., Bytchkov, A., Cristiglio, V., Palleau, P., Fischer, H. E., Cuello, G.J., Johnson, M., Melin, P., Zanghi, D., Brassamin, S., Brun, J.F., Price, D.L., Saboungi, M. L. (2006). Levitation Apparatus for Neutron Diffraction Investigations on High Temperature Liquids. Review of Scientific Instruments, 77(5).

[24]. Mathiak, G., Egry, I., Hennet, L., Thiaudière, D., Pozdnyakova, I., & Price, D. (2005). Aerodynamic Levitation and Inductive Heating - A New Concept for Structural Investigations of Undercooled Melts. International Journal of Thermophysics (26), 1151–1166.

[25]. Krishnan, S., Nordine, P. C., Weber, J. K. R., Schiffman, R. A. (1991). Optical Properties and Melting Point of Pure Boron. High Temperature Science, 31, 45.

[26]. Winborne, D. A., Nordine, P. C., Rosner, D. E., & Marley, N. F. (1976). Aerodynamic Levitation Technique for Containerless High Temperature Studies on Liquid and Solid Samples. Metallurgical Transactions B, 7(4), 711–713.

[27]. Weber, J. J. K., Krishnan, S., Ansell, S., Hixson, A. A., & Nordine, P. P. C. (2000). Structure of Liquid $Y_3Al_5O_{12}$ (YAG). Physical Review Letters, 84(16), 3622–5.

[28]. Wang, T. G., Anilkumar, A.V., L. C. P. (1996). Oscillations of Liquid Drops: Results from USML-1 Experiments in Space. Journal of Fluid Mechanics, 308, 1–14.

[29]. Cristiglio, V., Grillo, I., Fomina, M., Wien, F., Shalaev, E., Novikov, A., Brassamin, S., Réfrégiers, M., Pérez, J., Hennet, L. (2017). Combination of Acoustic Levitation with Small Angle Scattering Techniques and Synchrotron Radiation Circular Dichroism. Application to the Study of Protein Solutions. Biochimica et Biophysica Acta - General Subjects, 1861(1).

[30]. Weber, J. K. R., Krishnan, S., Schiffman, R. A., N. P. C. (1990). Containerless Processing of Amorphous Ceramics. In Containerless Experimentation in Microgravity Workshop, JPL, Pasadena, CA, 385–390.

[31]. Weber, J. K. R., Krishnan, S., N. P. C. (1991). The Use of Containerless Processing in Researching Reactive Materials. Journal of the Minerals, Metals, and Materials Society, 43, 8–14.

[32]. DeVos, J. K., Hampton, D. S., Merkley, D. R., Rey, C. A., Weber, J. K. R. (1992). International Journal of Microgravity Science and Application, 9, 146–161.

[33]. Weber, J. K. R., Hampton, D. S., Merkley, D. R., Rey, C. A., Zatarski, M. M., & Nordine, P. C. (1994). Aero-Acoustic Levitation: A Method for Containerless Liquid-Phase Processing at High Temperatures. Review of Scientific Instruments, 65(2), 456–465.

[34]. Biswas, A., Weber J.K.R., Nordine, P. C. (1995). Removal of Residual Chromium from Aluminum Oxide by Containerless Liquid-Phase Processing. Journal of Materials Research, 10, 1823–1827.

[35]. Weber J. K. R., N. P. C. (1995). Containerless Liquid-Phase Processing at High Temperatures. Microgravity Science and Technology, 7, 279–282.

[36]. Weber, J. K. R. (1995). Containerless Property Measurements on Molten Aluminum Oxide and Alumino-Silicate Binary Mixtures. 4th Asian Thermophysical Properties Conference, Tokyo, Ed. A. Nagashima, 873–876.

[37]. Weber, J.K.R., Felten, J.J., Cho, B., N. P. C. (1996). Design and Performance of the Aero-Acoustic Levitator. International Journal of Microgravity Science and Application, 13, 27–35.

[38]. Weber, J. K. R. (1996). The Status of Containerless Processing for Materials Research and Development. In Space '96, Tokyo, Japan, 91–118.

[39]. Weber, J. K. R. (1997). Behavior of Molten Oxides under Containerless Conditions. European Journal of Solid State and Inorganical Chemistry, 34, 847–859.

[40]. Nordine, P. C., Weber, J. K. R., & Abadie, J. G. (2000). Properties of High-Temperature Melts Using Levitation. Pure and Applied Chemistry, 72(11), 2127–2136.

[41]. Weber, J.K.R., Rix, J.E., Benmore, C.J., Hart, R.T., Hiera, K.J., Tangeman, J.A., Siewenie, J.E., S. L. J. (2006). Combined Levitation and Neutron Diffraction to Investigate Liquids and Solids at High Temperatures. ICANS-XVII, Santa Fe, New Mexico, III, 1102–1109.

[42]. Weber, J. K. R., Rey, C. A., Neuefeind, J., & Benmore, C. J. (2009). Acoustic Levitator for Structure Measurements on Low Temperature Liquid Droplets. Review of Scientific Instruments, 80(8).

[43]. Weber, J. K. R. (2010). The Containerless Synthesis of Glass. International Journal of Applied Glass Science, 1, 248–256.

[44]. Benmore, C.J., W. J. K. R. (2011). Amorphization of Molecular Liquids of Pharmaceutical Drugs by Acoustic Levitation. Physical Review X, 1(1).

[45]. Weber, R. J. K., Benmore, C. J., Tumber, S. K., Tailor, A. N., Rey, C. A., Taylor, L. S., & Byrn, S. R. (2012). Acoustic Levitation: Recent Developments and Emerging Opportunities iBiomaterials Research.European Biophysics Journal, 41(4), 397–403.

[46]. Benmore, C. J., Weber, J. K. R., Tailor, A. N., Cherry, B. R., Yarger, J. L., Mou, Q., Weber, W., Neuefeind, J., Byrn, S. R. (2013). Structural Characterization and Aging of Glassy Pharmaceuticals Made Using Acoustic Levitation. Journal of Pharmaceutical Sciences, 102(4), 1290–1300.

[47]. Weber, J. K. R., Benmore, C. J., Tailor, A. N., Tumber, S. K., Neuefeind, J., Cherry, B., Yarger, J.L., Mou, Q., Weber, W., Byrn, S. R. (2013). A Neutron-X-Ray, NMR and Calorimetric Study of Glassy Probucol Synthesized Using Containerless Techniques. Chemical Physics, 424, 89–92.

[48]. Weber, J. K. R., Benmore, C. J., Suthar, K. J., Tamalonis, A. J., Alderman, O. L. G., Sendelbach, S., Kondev, V., Yarger, J., Rey,C.A., Byrn, S. R. (2017). Using Containerless Methods to Develop Amorphous Pharmaceuticals. Biochimica et Biophysica Acta - General Subjects, 1861(1), 3686–3692.

[49]. Caccamo, M. T., Cannuli, A., Calabrò, E., & Magazù, S. (2017). Acoustic Levitator Power Device: Study of Ethylene-Glycol Water Mixtures. In IOP Conference Series: Materials Science and Engineering (199).

[50]. Lokotosh, T. V., Magazù, S., Maisano, G., & Malomuzh, N. P. (2000). Nature of Self-Diffusion and Viscosity in Supercooled Liquid Water. Physical Review E - Statistical Physics, Plasmas, Fluids, and Related Interdisciplinary Topics, 62(3 A), 3572–3580.

[51]. Magazù, S. (1996). IQENS - Dynamic Light Scattering Complementarity on Hydrogenous Systems. Physica B, 226, 92–106.

[52]. Magazù, S., Maisano, G., Mallamace, F., Micali, N., (1989). Growth of Fractal Aggregates in Water Solutions of Macromolecules by Light-Scattering. Physical Review A, 39, 4195–4200.

[53]. Jannelli M.P., Magazù S., Migliardo P., Aliotta, F., Tettamanti, E. (1996). Transport Properties of Liquid Alcohols Investigated by IQENS, NMR and DLS Studies. Journal of Physics: Condensed Matter, 8(43).

[54]. Magazù, S., Migliardo, F., & Telling, M. T. F. (2008). Structural and Dynamical Properties of Water in Sugar Mixtures. Food Chemistry, 106(4 SPEC. ISS.), 1460–1466.

[55]. Magazù, S., Calabrò, E., Caccamo, M. T., & Cannuli, A. (2016). The Shielding Action of Disaccharides for Typical Proteins in Aqueous Solution Against Static, 50 Hz and 1800 MHz Frequencies Electromagnetic Fields. Current Chemical Biology, 10(1).

[56]. Branca, C., Magazu, S., Maisano, G., Migliardo, P., Villari, V., & Sokolov, A. P. (1999). The Fragile Character and Structure-Breaker Role of Alpha, Alpha-Trehalose: Viscosity and Raman Scattering Findings.Journal of Physics-Condensed Matter, 11(19), 3823–3832.

[57]. Magazù, S., Maisano, G., Migliardo, P. Middendorf, H.D. Villari, V. (1998). Hydration and Transport Properties of Aqueous Solutions of α-α Trehalose. Journal of Chemical Physics, 109, 1170–1174.

[58]. Ballone, P., Marchi, M., Branca, C., & Magazu, S. (2000). Structural and Vibrational Properties of Trehalose: A Density Functional Study. Journal of Physical Chemistry B, 104(26), 6313–6317.

[59]. Magazu, S., Maisano, G., Migliardo, P., Tettamanti, E., & Villari, V. (1999). Transport Phenomena and Anomalous Glass-Forming Behaviour in Alpha, Alpha-Trehalose Aqueous Solutions. Molecular Physics, 96(3), 381–387.

[60]. Magazu, S., Maisano, G., Middendorf, H. D., Migliardo, P., Musolino, A. M., & Villari, V. (1998). Alpha, Alpha-Trehalose-Water Solutions. II. Influence of Hydrogen Bond Connectivity on Transport Properties. Journal of Physical Chemistry B, 102(11), 2060–2063.

[61]. Minutoli, L., Altavilla, D., Bitto, A., Polito, F., Bellocco, E., Laganà, G., Squadrito, F. (2008). Trehalose: A Biophysics Approach to Modulate the Inflammatory Response During Endotoxic Shock.European Journal of Pharmacology, 589(1–3), 272–280.

[62]. Pagnotta, S. E., Ricci, M. A., Bruni, F., McLain, S., & Magazù, S. (2008). Water Structure Around Trehalose. Chemical Physics, 345(2–3), 159–163.

[63]. Magazù, S., Migliardo, F., & Telling, M. T. F. (2007). Study of the Dynamical Properties of Water in Disaccharide Solutions.European Biophysics Journal, 36(2), 163–171.

[64]. Branca, C., Magazù, S., Maisano, G., Migliardo, P., & Magazu, S. (1999). Alpha,Alpha-Trehalose-Water Solutions. 3. Vibrational Dynamics Studies by Inelastic Light Scattering. Journal of Physical Chemistry B, 103(8), 1347–1353.

[65]. Magazu, S., Maisano, G., Migliardo, P., & Villari, V. (1999). Experimental Simulation of Macromolecules in Trehalose Aqueous Solutions: A Photon Correlation Spectroscopy Study. Journal of Chemical Physics, 111(19), 9086–9092.

[66]. Minutoli, L., Altavilla, D., Bitto, A., Polito, F., Bellocco, E., Laganà, G., Giuliani, D., Fiumara, T., Magazù, S., Ruggeri, P., Guarini, S.,Squadrito, F. (2007). The Disaccharide Trehalose Inhibits Proinflammatory Phenotype Activation in Macrophages and Prevents Mortality in Experimental Septic Shock. Shock Society, 27(1), 91–96.

[67]. Magazù, S., Calabrò, E., & Campo, S. (2010). FTIR Spectroscopy Studies on the Bioprotective Effectiveness of Trehalose on Human Hemoglobin Aqueous Solutions Under 50 Hz Electromagnetic Field Exposure.Journal of Physical Chemistry B, 114(37), 12144–12149.

[68]. Barreca, D., Laganà, G., Ficarra, S., Tellone, E., Leuzzi, U., Magazù, S., Galtieri, A., Bellocco, E. (2010). Anti-Aggregation Properties of Trehalose on Heat-Induced Secondary Structure and Conformation Changes of Bovine Serum Albumin. Biophysical Chemistry, 147(3), 146–152.

[69]. Magazù, S., Migliardo, F., Affouard, F., Descamps, M., & Telling, M. T. F. (2010). Study of the Relaxational and Vibrational Dynamics of Bioprotectant Glass-Forming Mixtures by Neutron Scattering and Molecular Dynamics Simulation. Journal of Chemical Physics, 132(18).

[70]. Varga, B., Migliardo, F., Takacs, E., Vertessy, B., Magazù, S., & Mondelli, C. (2008). Neutron Scattering Studies on dUTPase Complex in the Presence of Bioprotectant Systems. Chemical Physics, 345(2–3), 250–258.

[71]. Migliardo F., Caccamo M.T., M. S. (2014). Thermal Analysis on Bioprotectant Disaccharides by Elastic Incoherent Neutron Scattering. Food Biophysics, 9, 99–104.

[72]. Magazù, S., Migliardo, F., Vertessy, B. G., & Caccamo, M. T. (2013). Investigations of Homologous Disaccharides by Elastic Incoherent Neutron Scattering and Wavelet Multiresolution Analysis. Chemical Physics, 424, 56–61.

[73]. Migliardo, F., Caccamo, M. T., & Magazù, S. (2013). Elastic Incoherent Neutron Scatterings Wavevector and Thermal Analysis on Glass-Forming Homologous Disaccharides. Journal of Non-Crystalline Solids, 378, 144–151.

[74]. Branca, C., Magazù, S., Maisano, G., Bennington, S. M., & Fåk, B. (2003). Vibrational Studies on Disaccharide/H_2O Systems by Inelastic Neutron Scattering, Raman, and IR Spectroscopy. The Journal of Physical Chemistry B, 107(6), 1444–1451.

[75]. Magazù S., Migliardo F., B. A. (2010). Mean Square Displacements from Elastic Incoherent Neutron Scattering Evaluated by Spectrometers Working with Different Energy Resolution on Dry and Hydrated (H_2O and D_2O) Lysozyme. Journal of Physical Chemistry B, 114, 9268–9274.

[76]. Fenimore, P. W., Frauenfelder, H., Magazù, S., McMahon, B. H., Mezei, F., Migliardo, F., Young, R.D., Stroe, I. (2013). Concepts and Problems in Protein Dynamics. Chemical Physics, 424, 2–6.

[77]. Barreca, D., Lagana, G., Bruno, G., Magazù, S., Bellocco, E. (2013). Diosmin Binding to Human Serum Albumin and its Preventive Action Against Degradation Due to Oxidative Injuries. Biochimie, 95(11), 2042–2049.

[78]. Magazù, S., Migliardo, F., Benedetto, A., Mondelli, C., & Gonzalez, M. A. (2011). Thermal Behaviour of Hydrated Lysozyme in the Presence of Sucrose and Trehalose by EINS. In Journal of Non-Crystalline Solids (357), 664–670.

[79]. Magazù, S. (2000). NMR, Static and Dynamic Light and Neutron Scattering Investigations on Polymeric Aqueous Solutions.Journal of Molecular Structure, 523(1–3), 47–59.

[80]. Faraone, A., Magazù, S., Maisano, G., Ponterio, R., & Villari, V. (1999). Experimental Evidence of Slow Dynamics in Semidilute Polymer Solutions. Macromolecules, 32(4), 1128–1133.

[81]. Faraone, A., Magazù, S., Maisano, G., Migliardo, P., Tettamanti, E., & Villari, V. (1999). The Puzzle of Poly (EthyleneOxide) Aggregation in Water: Experimental Findings. The Journal of Chemical Physics, 110(3), 1801–1806.

[82]. Branca, C., Faraone, A., Magazù, S., Maisano, G., Migliardo, P., Villari, V. (2000). Polyethylene Oxide: a Review of Experimental Findings by Spectroscopic Techniques. Journal of Molecular Liquids, 87(1), 21–68.

[83]. Branca, C., Faraone, A., Maisano, G., Magazù, S., Migliardo, P., Triolo, A., Triolo, R., Villari, V. (1999). Can the Isotopic H<->D Substitution Affect the Conformational Properties of Polymeric Aqueous Solutions? The Poly (EthyleneOxide)-Water Case. Journal of Physics and Condensed Matter.

[84]. Branca, C., Magazù, S., Maisano, G., Migliardo, P., Migliardo, F., & Romeo, G. (2002b). Hydration Parameters of Aqueous Solutions of Poly (EthyleneGlycol)s by Viscosity Data. Physica Scripta, 66(2), 175.

[85]. Branca, C., Magazù, S., Maisano, G., Migliardo, F., Migliardo, P., Romeo, G. (2003). Study of Conformational Properties of Poly (EthyleneOxide) by SANS and PCS Techniques. Physica Scripta, 67, 551–554.

[86]. Branca, C., Faraone, A., Magazù, S., Maisano, G., Migliardo, P., Triolo, A., Triolo, R., Villari, V. (2000b). Anomalous Conformational Properties of PEO in H_2O and D_2O by SANS, PCS and Raman Scattering. Journal of Applied Crystallography, 33(3), 709–713.

[87]. Magazù, S., Maisano, G. (2001). New Experimental Results in Physics of Liquids. Journal of Molecular Liquids, 93(1–3), 7–27.

[88]. Branca, C., Magazù, S., Maisano, G., Auditore, L., Barnà, R.C., De Pasquale, D., Emanuele, U., Trifirò, A., Trimarchi, M. (2006). Synthesis of PolyEthylene Oxide Hydrogels by Electron Radiation. Journal of Applied Polymer Science, 102, 820–824.

[89]. Branca, C., Magazù, S., Maisano, G., Migliardo, P., & Tettamanti, E. (1999). Criticism to Light-Heavy Water Substitution in Structural Studies of Macromolecular Aqueous Solutions. Physica B: Condensed Matter, 270(3–4), 350–359.

[90]. Branca, C., Faraone, A., Lokotosh, T., Magazu, S., Maisano, G., Malomuzh, N. P., Migliardo, P., Villari, V. (2001). Diffusive Dynamics: Self vs. Collective Behaviour. Journal of Molecular Liquids (93), 139–149.

[91]. Faraone, A., Branca, C., Magazù, S., Maisano, G., Middendorf, H. D., Migliardo, P., & Villari, V. (2000). QENS and PCS Study of Aqueous BSA-PEO 'crowded' Solutions. Physica B: Condensed Matter, 276–278, 524–525.

[92]. Triolo, R., Arrighi, V., Triolo, A., Migliardo, P., Magazù, S., McClain, J. B., Betts, D., Desimone,J.M., Middendorf, H. D. (2000). QENS from Polymer Aggregates in Supercritical CO_2. Physica B: Condensed Matter, 276–278, 386–387.

[93]. Branca, C., Faraone, A., Magazù, S., Maisano, G., Migliardo, P., & Villari, V. (1999). Swelling Processes in Aqueous Polymer Solutions by PCS and Raman Scattering. Journal of Molecular Structure (482–483), 503–507.

[94]. Magazù, S., Villari, V., Faraone, A., Maisano, G., & Janssen, S. (2002). Effect of the Monomer Structure On The Dynamics Of Semidilute Polyalkylmethacrylate Solutions: A Quasi Elastic Light and Neutron Scattering Investigation. Journal of Chemical Physics, 116(1), 427–435.

[95]. Faraone, A., Magazù, S., Maisano, G., Villari, V., & Maschio, G. (1999). Possibilities and Limits of Photon Correlation Spectroscopy in Determining Polymer Molecular Weight Distributions. Macromolecular Chemistry and Physics, 200(5), 1134–1142.

[96]. Branca, C., Magazù, S., Maisano, G., Migliardo, F., Migliardo, P., Romeo, G., Vertessy, B. (2001). Conformational Studies of Poly (Ethylene Oxide) in Crystalline, Molten, and Solution Phase. Molecular Crystals and Liquid Crystals Science and Technology Section A: Molecular Crystals and Liquid Crystals, 372, 17–23.

[97]. Magazù, S., Migliardo, F., Barreca, D., Bellocco, E., & Laganà, G. (2008). Neutron Scattering Study on the Interaction Between Polyethylene Glycol and Lysozyme. Physica B: Condensed Matter, 403(13–16), 2408–2412.

[98]. Villari, V., Faraone, A., Magazù, S., Maisano, G., Ponterio, R. (2000). Dynamical Properties of Highly Entangled Polyalkylmethacrylate Solutions: A Comparative Study. Journal De Physique. IV: JP, 10(7), 321–324.

[99]. Branca, C., Faraone, A., Magazù, S., Maisano, G., Migliardo, P., Triolo, A., Triolo R., Villari, V. (2000a). Effects of Isotopic Substitution on the Conformational Properties of Polymeric Aqueous Solutions.Physica B: Condensed Matter, 276–278, 332–333.

[100]. Faraone, A., Branca, C., Magazù, S., Maisano, G., Migliardo, P., Villari, V. (2000). Slow Dynamics Features in Aqueous Solutions of High Molecular Weight Poly (Ethylene Oxide). In AIP Conference Proceedings, (513), 118–121.

[101]. Magazù, S., Branca, C., Faraone, A., Maisano, G., Migliardo, P., Villari, V. (2000). On the Aggregation of Poly (Ethylene Oxide) in Water. In AIP Conference Proceedings, (513), 146–149.

[102]. Triolo, R., Arrighi, V., Triolo, A., Migliardo, P., Magazù, S., McClain, J. B., Betts, D., DeSimone, J. M., Middendorf, H. D. (2000). QENS from Polymeric Micelles in Supercritical CO_2. In AIP Conference Proceedings (513), 234.

[103]. Faraone, A., Magazù, S., Maisano, G., Migliardo, P., Tniolo, A., Triolo, R., Vlllari, V. (1999). PCS and SANS Studies on PEO-H_2O Systems. Nuovo Cimento Della Societa Italiana Di Fisica D - Condensed Matter, Atomic, Molecular and Chemical Physics, Biophysics, 20, 2531–2540.

[104]. Magazù, S., Maisano, G., Migliardo, R., Tettamanti, E. (1999). Diffusive Dynamics of Polymeric Aqueous Solutions by NMR and DLS. Nuovo Cimento Della Societa Italiana Di Fisica D - Condensed Matter, Atomic, Molecular and Chemical Physics, Biophysics, 20, 2521–2530.

[105]. Aliotta, F., Fontanella, M.E., Magazù, S., Wanderlingh, U. (1991). Hypersonic Properties in Macromolecular Aqueous Solutions. Progress in Colloid and Polymer Science, (84), 483–486.

[106]. Branca, C., Magazù, S., Maisano, G., Migliardo, P., & Villari, V. (1998). Conformational Distribution of Poly (EthyleneOxide) in Molten Phase and in Aqueous Solution by Quasi-Elastic and Inelastic Light Scattering. Journal of Physics: Condensed Matter, 10(45), 10141.

[107]. Migliardo, F., Magazù, S., & Caccamo, M. T. (2013). Infrared, Raman and INS Studies of Poly-EthyleneOxide Oligomers. Journal of Molecular Structure, 1048, 261–266.

[108]. Caccamo M.T., Magazù, S. (2016). Tagging the Oligomer-to-Polymer Crossover on EG and PEGs by Infrared and Raman Spectroscopies and by Wavelet Cross-Correlation Spectral Analysis. Vibrational Spectroscopy, 85, 222–227.

[109]. Caccamo M.T., Magazù, S. (2017). Ethylene Glycol - Polyethylene Glycol (EG-PEG) Mixtures: Infrared Spectra Wavelet Cross-Correlation Analysis. Applied Spectroscopy, 71(3), 401–409.

[110]. Caccamo, M. T., & Magazù, S. (2017). Multiscaling Wavelet Analysis of Infrared and Raman Data on Polyethylene Glycol 1000 Aqueous Solutions. Spectroscopy Letters.

[111]. Apicella, A., Cappello, B., Del Nobile, M. A., La Rotonda, M. I., Mensitieri, G., & Nicolais, L. (1993). Poly (EthyleneOxide) (PEO) and Different Molecular Weight PEO Blends Monolithic Devices for Drug Release. Biomaterials, 14(2), 83–90.

[112]. Branca, C., Magazù, S., Maisano, G., Migliardo, F., Migliardo, P., & Romeo, G. (2002a). Hydration Study of PEG/Water Mixtures by Quasi Elastic Light Scattering, Acoustic and Rheological Measurements. Journal of Physical Chemistry B, 106(39), 10272–10276.

[113]. Chen, J., Spear, S. K., Huddleston, J. G., & Rogers, R. D. (2005). Polyethylene Glycol and Solutions of Polyethylene Glycol as Green Reaction Media. Green Chemistry, 7(2), 64.

[114]. Gonzalez-Tello, P., Camacho, F., & Blazquez, G. (1994). Density and Viscosity of Concentrated Aqueous Solutions of Polyethylene Glycol. Journal of Chemical & Engineering Data, 39(3), 611–614.

[115]. Acharya, S. A.; Acharya, V. N.; Kanika, N. D.; Tsai, A. G. M. Intaglietta, B. Manjula, N. (2007). Non-Hypertensive TetraPEGylated Canine Haemoglobin: Correlation Between PEGylation, O_2 Affinity and Tissue Oxygenation. Biochemical Journal, 405(3), 503–511.

[116]. Hu, T., Manjula, B. N.; Li, D. X.; Brenowitz, M.; Acharya, S. A. (2007). Influence of Intramolecular Cross-Links on the Molecular, Structural and Functional Properties of PEGylated Haemoglobin. Biochemical Journal, 402, 143–151.

[117]. Arumugam, V., Akalya, A., Rajasekaran, J. F., Balakrishnan, B. (2000). Ultrasonic Studies on PEG in Benzene. Journal of Polymer Materials, 17, 371–376.

[118]. Smith, G.D., Bedrov, D.; Borodin, O. (2000). Conformations and Chain Dimensions of Poly (Ethylene Oxide) in Aqueous Solution: a Molecular Dynamics Simulation Study. Journal of the American Chemical Society, 122, 9548–9549.

[119]. Rostovtseva, T. K., Nestorovich, E. M., & Bezrukov, S. M. (2002). Partitioning of Differently Sized Poly (EthyleneGlycol)s into OmpF porin. Biophysical Journal, 82(1 Pt 1), 160–9.

[120]. Venkatramanan, K. (2011). A Study on the Molecular Interaction of PEG 1000 and its Blend in Toluene Using Ultrasonic Technique. International Review of Chemical Engineering, 3, 308–311.

[121]. Cerveny, S., Alegría, Á., & Colmenero, J. (2008). Universal Features of Water Dynamics in Solutions of Hydrophilic Polymers, Biopolymers, and Small Glass-Forming Materials.Physical Review E - Statistical, Nonlinear, and Soft Matter Physics, 77(3).

[122]. Jonsson, B., Lindman, B., & Holmberg, K. (1998). Surfactants and Polymers in Aqueous Solutions. IEEE Electrical Insulation Magazine, 14(5), 42–43.

[123]. Flory, P. J. (1953). Principles of Polymer Chemistry. Cornell University Press, Ithaca, New York, 399.

[124]. Li, W., Kim, Y., Lia, J., Lee, M. (2014). Dynamic Self-Assembly of Coordination Polymers in Aqueous Solution. Soft Matter, 10, 5231–5242.

[125]. Cappello, B., Del Nobile, M. A., La Rotonda, M. I., Mensitieri, G., Miro, A., & Nicolais, L. (1994). Water Soluble Drug Delivery Systems Based on a Non-Biological Bioadhesive Polymeric System.Farmaco (Societa Chimica Italiana : 1989), 49(12), 809–818.

[126]. Braun, A., Stenger, P. C., Warriner, H. E., Zasadzinski, J. a, Lu, K. W., & Taeusch, H. W. (2007). A Freeze-Fracture Transmission Electron Microscopy and Small Angle X-Ray Diffraction Study of the Effects of Albumin, Serum, and Polymers on Clinical Lung Surfactant Microstructure. Biophysical Journal, 93(1), 123–39.

[127]. Zimmerberg, J., & Parsegian, V. A. (1986). Polymer Inaccessible Volume Changes During Opening and Closing of a Voltage-Dependent Ionic Channel. Nature, 323(6083), 36–9.

[128]. Magazù, S., Migliardo, F., Malomuzh, N. P., & Blazhnov, I. V. (2007). Theoretical and Experimental Models on Viscosity: I. Glycerol. Journal of Physical Chemistry B, 111(32), 9563–9570.

[129]. Chelli, R., Procacci, P., Cardini, G., & Califano, S. (1999). Glycerol Condensed Phases {P}Art {II}. {A} Molecular Dynamics Study of the Conformational Structure and Hydrogen Bonding. Physical Chemistry and Physics, 1(5), 879–885.

[130]. Zondervan, R., Kulzer, F., Berkhout, G. C. G., & Orrit, M. (2007). Local Viscosity of Supercooled Glycerol Near Tg Probed by Rotational Diffusion of Ensembles and Single Dye Molecules. Proc. Natl. Acad. Sci. U. S. A., 104(31), 12628–12633.

[131]. Bradbury, S. L., & Jakoby, W. B. (1972). Glycerol as an Enzyme-Stabilizing Agent: Effects on Aldehyde Dehydrogenase. Proceedings of the National Academy of Sciences of the United States of America, 69(9), 2373–6.

[132]. Grandori, R., Matecko, I., Mayr, P., & Muller, N. (2001). Probing Protein Stabilization by Glycerol Using Electrospray Mass Spectrometry.J Mass Spectrom, 36(8), 918–922.

[133]. Towey, J. J., Soper, A. K., & Dougan, L. (2011a). Preference for Isolated Water Molecules in a Concentrated Glycerol-Water Mixture.Journal of Physical Chemistry B, 115(24), 7799–7807.

[134]. Towey, J. J., Soper, A.K., & Dougan, L. (2011b). The Structure of Glycerol in the Liquid State: A Neutron Diffraction Study.Physical Chemistry Chemical Physics : PCCP, 13(20), 9397–406.

[135]. Magazù, S., Migliardo, F., & Caccamo, M. T. (2013). Upgrading of Resolution Elastic Neutron Scattering (RENS). Advances in Materials Science and Engineering.

[136]. Magazù, S., Maisano, G., Migliardo, F., Galli, G., Benedetto, A., Morineau, D., Affouard, F., D. M. (2008). Characterization of Molecular Motions in Biomolecular Systems by Elastic Incoherent Neutron Scattering. Journal of Chemical Physics, 129.

[137]. Magazù, S., Migliardo, F., & Benedetto, A. (2011). Elastic Incoherent Neutron Scattering Operating by Varying Instrumental Energy Resolution: Principle, Simulations, and Experiments of the Resolution Elastic Neutron Scattering (RENS). Review of Scientific Instruments, 82(10).

[138]. Magazù, S., Maisano, G., Migliardo, F., B. A. (2008). Elastic Incoherent Neutron Scattering on Systems of Biophysical Interest: Mean Square Displacement Evaluation from Self-Distribution Function. Journal of Physical Chemistry B, 112, 8936–8942.

[139]. Magazù, S., Magazù, S., Maisano, G., Maisano, G., Migliardo, F., Migliardo, F., Benedetto, A. (2009). Biomolecular Motion Characterization by a Self-Distribution-Function Procedure in Elastic Incoherent Neutron Scattering. Physical Review E, 79, 41915.