I J R H

REVIEW ARTICLE

Access this article online

Website: www.ijrh.org

DOI: 10.4103/0974-7168.166372

Quick Response Code:

A review of Basic Research on Homoeopathy from a physicist's point of view

Papiya Nandy

Centre for Interdisciplinary Research and Education, Kolkata, West Bengal, India

Address for correspondence:
Prof. Papiya Nandy,
Centre for Interdisciplinary Research and Education,
404 B, Jodhpur Park,
Kolkata - 700 068,
West Bengal, India.
E-mail: pnandy00@yahoo.com

Received: 07-05-2015
Accepted: 06-08-2015

ABSTRACT

Homoeopathic medicine has been one of the world's most widely practiced alternative therapies. However, that the potency of a homoeopathic medicine increases with dilution followed by succussion (together termed as potentization) has thrown challenges to the scientific community at large. A recent hypothesis, advanced by us and others, is that due to the process of potentization, the size of the constituent particles decreases and eventually reaches nanodimension. This decrease in size with increase in potency has been verified by scanning electron microscopy and dynamic light scattering studies. The increase in potency is manifested in its increased effect on membrane fluidity. The change in potency also leaves its signature on Ultraviolet–Visible spectra, Fourier transform infrared radiation spectra and Raman spectra. We have taken one step further to carry this nano-dimensional property of homoeopathic medicine and put it into several technical applications. And in so doing, we have connected the important, old, un-quantifiable effects with the latest quantifiable technology and opened up an era of applications with more possibilities.

Keywords: Anisotropy, Characterization, Homoeopathy, Nanomedicine, Nano-technology, Potentization

INTRODUCTION

Homoeopathy is a time-tested, empirical system of healing that has been used universally for more than 200 years, because of its negligible side effects, low cost, easy availability, and easy applicability. The fact that these medicines are active at extreme dilution (dilution factor even beyond 10^{400}) and that one sample of such apparent 'zero' concentration is different from another sample of apparent "zero" concentration have posed insurmountable obstacles to acceptance by the conventional scientific community, leading to the stance that these medicines have only a placebo effect.

The ultrahigh dilution doses, as are often prescribed in Homoeopathy, can exhibit biological and pharmacological activities was the controversial finding by the group of Davenas *et al*. 1988.[1] This was regarded as 'unbelievable' by the so-called academic science,[2] though the clinical action of the medicine at very high dilution on plants, animals, and human beings has been convincingly shown by several groups of researchers. Over the years,

How to cite this article: Nandy P. A review of Basic Research on Homoeopathy from a physicist's point of view. Indian J Res Homoeopathy 2015;9:141-51.

there has been thorough study on the search for a molecular mechanism of action of potentized homoeopathic drugs in living organisms[3] and experimental evidences are given in support of the biological effects and physical basis of homoeopathic potencies.[4] To explain the action of homoeopathic drugs in all living systems, 'gene regulatory hypothesis' has been put forward.[5]

To explain this unique phenomenon that, unlike allopathy medicines, the homoeopathic medicine becomes more potent at higher dilution, several hypotheses have been put forward, ranging from liquid memory, clathrate formation, quantum mechanics, relativity etc. The Silica hypothesis suggests the presence of physical entities,[6] whereas the liquid memory hypothesis is supported by Elia *et al*.[7]

It has been realized that the Very Low Molarity Repetitive Successive Diluted Liquid (VLMRSDL), of which homoeopathic medicine is an example, has properties that are modified significantly from the original liquid. This is reflected in the measured values of Nuclear Magnetic Resonance (NMR),[8] Ultraviolet (UV) transmission, Dielectric behaviour, Electrical conductivity, and heat of mixing measurements of the resulting VLMRSDL.[9] Quantum field theory analysis of experimental data for VLMRSDL indicates that succussion excites rotons and phonons that are responsible for the change in potency of the medicine.[10] In a different context, Maity *et al*. have shown that a characteristic set of resonance frequencies exists for different potencies of the drug *Cuprum metallicum*.[11]

In order to study and compare their physical properties, such as spectral characteristics, size distribution at different potencies, and effect on membrane fluidity, we have worked with two different homoeopathic drugs, *C. metallicum*, which is metal-derived and hydrophilic in nature,[12] and *Aconitum napellus*, which is plant-derived and hydrophobic in nature.[13] In both cases, experimental evidences are there to prove that the potency of the drug plays a very significant role in its physicochemical properties.

EFFECT OF POTENCY ON THE SIZE OF THE DRUG PARTICLES

We posed the question that does the process of dilution and succussion (together termed as potentization) alter the size of nanoparticles of homoeopathic medicines?

Nanoparticles are synthesized in laboratories by transferring mechanical energy through wet ball milling process. It was our assumption that perhaps the succussion process used in preparing high-potency homoeopathic medicine and in which a large amount of mechanical energy (~404.3 Newton-meter for 10 strokes)[14] is transferred, causes the size reduction of the original aggregated drug particles to nano-dimension in a similar way.

The indirect evidence of existence of nanoparticles at extreme potencies of the homoeopathic medicine *Aconitum napellus* was suggested by Nandy *et al*. and was first reported in an International Conference, held in January 2010 and later two papers were published on this issue in peer reviewed journals in 2011.[13,15] Using homoeopathic remedies prepared from a metal powder, Chikramane *et al*. documented the presence of nanoparticles in them.[16] The experiments of Upadhyay and Nayak[17] exhibited high nanoparticle contents, rich in Silicon and with crystalline nature, but the size distribution of the nanoparticles and their clusters were found to be nearly the same at different potencies. According to these authors, the nanoparticles might acquire the information of the starting source encrypted on them by means of epitaxy - the growing of a crystal on top of another crystal, where its orientation is determined by the underlying crystal. Chikramane *et al*.[18] have also shown that triturated synthetic gold nanoparticles, which mimic the ultrafine gold powder that results from the grinding process used in producing homeopathic medicines, levitate to the surface and are preserved there as a monolayer at the air–liquid interface. This topology is carried through the subsequent steps of dilution, forming an asymptotic concentration. These experiments have been reviewed by Frye.[19]

Using dynamic light scattering (DLS) and high-resolution transmission electron microscopy (HRTEM) studies, Ghosh *et al*.[12] have reported that the size of *C. metallicum* drug particles indeed decreases with increase in potency [Figure 1A].

The mean size of the nanoparticles of *C. metallicum* at three different potencies 6C, 30C, and 200C, as measured by DLS, are approximately in the range of 13.5–18.5 nm, 1.5–1.7 nm, and 0.62 nm, respectively [Figure 1A: a-c]. This is also supported by the HRTEM measurements [Figure 1A: d-f]. However, the size distribution, obtained from DLS study when

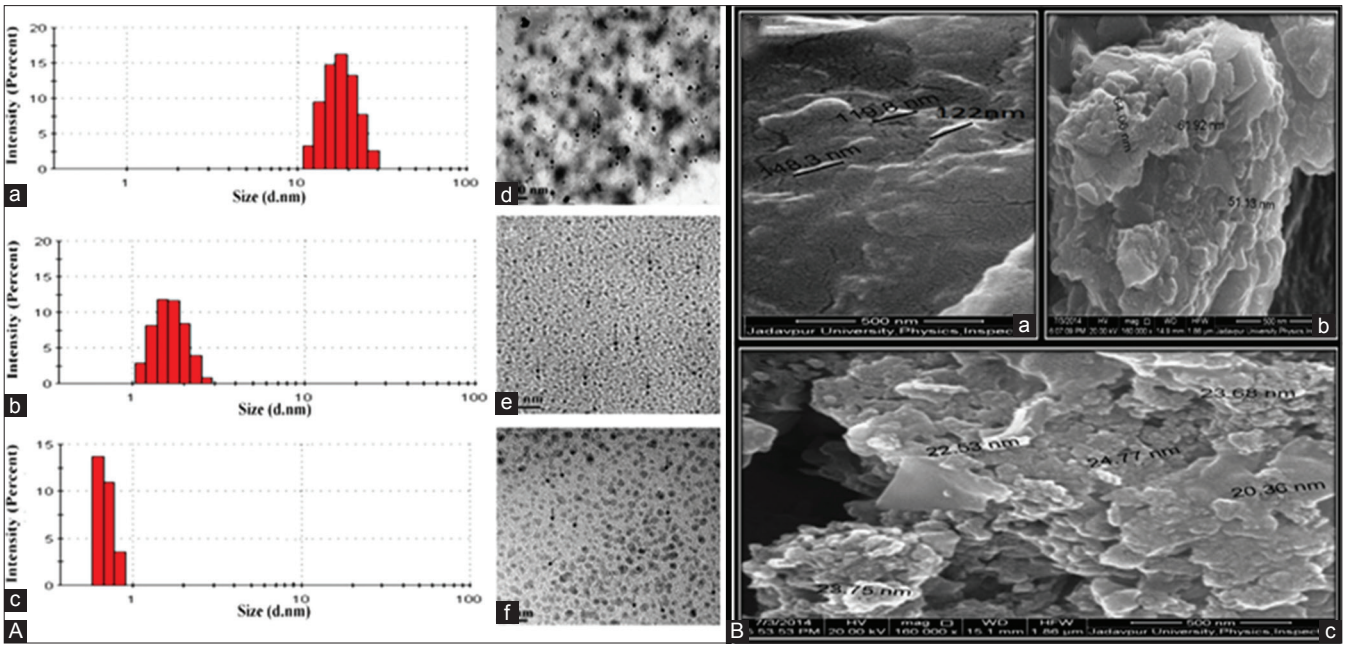

Figure 1: (A) (a) For homoeopathic medicine *Cuprum metallicum*, a metal-derived homoeopathic medicine, size distribution as estimated by dynamic light scattering measurement (a-c) and high-resolution transmission electron microscopy image (d-f). Here (a and d) are for potency 6C; (b) and (e) for potency 30C; (c) and (f) for potency 200C. (B) Field emission-scanning electron microscopy image of homoeopathic medicine *Aconitum napellus*, a plant-derived homoeopathic medicine, (a) is for potency 6C; (b) and (c) are for potencies 30C and 200C

the experimental sample was in the liquid state, is not exactly the same as measured by HRTEM image study where aggregation takes place during drying the sample under vacuum.

The zeta potential for *C. metallicum* is negative due to the fact that the lone pair from the hydroxyl group coming from the lactose, which was used in the preparation of the drug, provides an electron-rich environment on the surface of the nanoparticles.[12] This confers stability and particles have less chances of aggregation.

The field emission-scanning electron microscopy diagram [Figure 1B: a-c] of the drug *A. napellus* at different potencies shows how with increase in potency the polydispersive drug aggregates change to mono-dispersive ones with decrease in aggregate size. Here the sample was prepared by drop cast method where there is possibility of aggregation. The figure shows that at 6C potency of the drug, the average dimension of the drug-aggregate lies between 120 nm and 150 nm. The range of dimension of the drug-aggregates is within 51–64 nm for 30C potency, while it reduces to 20–25 nm for 200C potency of the drug[20] [Table 1].

The origin of the two medicines *C. metallicum*, a metal-derived homoeopathic medicine, and *A. napellus*, a plant-derived homoeopathic medicine being different, and the images are also different; for the former it is more well defined, while for the later it is not.

Table 1: Comparison of fluidity parameters of *A. napellus* (Drug A) with that of *C. metallicum* (Drug B)

Potency of drug	Size in (nm)		Phase transition temperature (T_m in °C)		Fraction of motionally restricted lipids (χ)	
	Drug A	Drug B	Drug A	Drug B	Drug A	Drug B
Control		-	42	41	0	0
6C	120-150	13.5-18.2	44	37.7	0.02	0.33
30C	51-64	1.5-1.7	44.6	38.8	0.02	0.087
200C	20-25	~0.62	45	38.8	0.04	0.025

χ: Ratio of motionally restricted lipid molecules

EFFECT OF POTENCY ON SPECTRAL PROPERTIES

Rao *et al.*[21] have shown that Raman and UV spectroscopy can differentiate between the different potencies of a given medicine. Proton NMR relaxation study by Demangeat[8] demonstrated modifications of the solvent throughout the low to ultramolecular range of dilution and existence of superstructure even beyond 12C.

Ultraviolet-visible Spectroscopy study of *Cuprum metallicum* and *Aconitum napellus*

The absorption spectra at three potencies namely 6C, 30C, and 200C of *C. metallicum* and *A. napellus* are shown in Figure 2a and b, respectively.

In each absorption spectrum [Figure 2a and b], there are two absorption maxima whose intensity increase in magnitude with increase in potency associated with a blue shift. This effect can be explained as follows: The decrease in particle size gives rise to an increase in the surface to bulk ratio, thus increasing the absorption of radiation, which in turn increases the height of the absorption peaks. With the decrease in particle size, the gap between the associated energy levels increases, leading to the blue shift as observed in the UV–visible (UV–vis) spectrum. Using gold nanoparticles, He *et al*.[22] have shown that similar results are obtained, where gold nanoparticles have specific absorption spectra depending upon the dimension of the particles, and there are gradual blue shifts with decrease in diameter of the particles.

Fourier Transform Infrared Radiation Study of *Cuprum metallicum* and *Aconitum napellus*

Comparison of Fourier Transform Infrared Radiation (FTIR) spectra between different potencies of the drug *C. metallicum* [Figure 3a] clearly indicates the increment in absorption with increase in potency of the drug. Three bands appear in the wave number range 600–2500 cm^{-1}, of which the one at 2350 cm^{-1} corresponds to O=C=O stretching of CO_2, the one at 1620 cm^{-1} corresponds to C=C alkenyl stretch, and the band at 667 cm^{-1} is due to −O-H stretching vibration in −C-O-H group.

Comparison of FTIR spectra [Figure 3b] between 3 different potencies of the drug *A. napellus* reveals that peaks for all the three potencies are obtained at the same position, but the peak intensity and sharpness increase with increase in potency.

The band at 1385 cm^{-1} corresponds to phenol or tertiary alcohol, OH bend, the band at 1653 cm^{-1} corresponds to C=C stretch, the band at 2873 cm^{-1} corresponds to methyl C-H asym/sym stretch, and the band at 3351 cm^{-1} corresponds to normal polymeric OH stretch and hydroxyl group, H bonded OH stretch.[23] The minor blue shift may be the effect of succussion on the bond strength of the OH bond and H bond.

The drug–membrane interaction is basically driven by electrostatic force. The FTIR spectra records the presence of multiple hydroxyl groups coming from the lactose [Figure 3a], used here in the preparation of the drug as a surface stabilizer. The lone pair

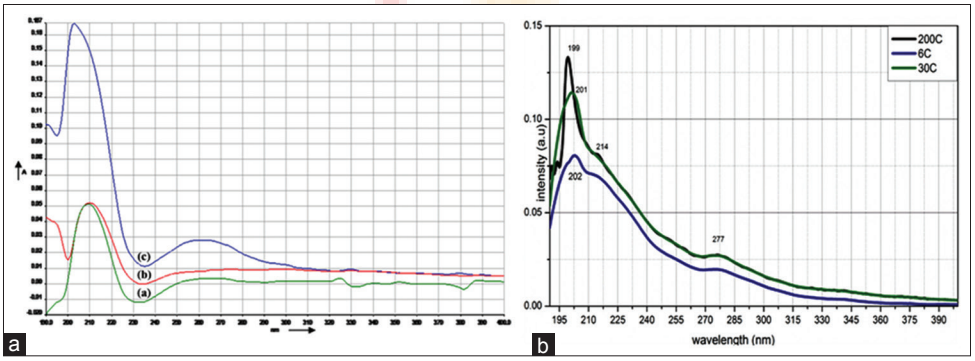

Figure 2: Ultraviolet–visible absorption spectra at three different potencies: 6C, 30C, and 200C of (a) *Cuprum metallicum* and (b) *Aconitum napellus*

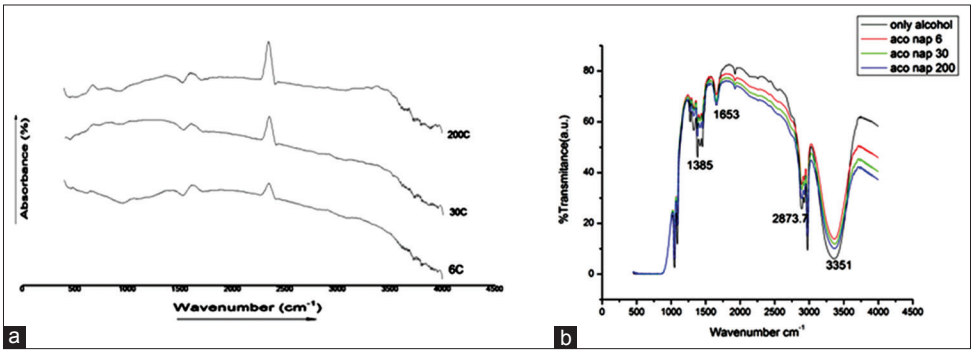

Figure 3: Fourier transform infrared radiation spectra at three different potencies: 6C, 30C, and 200C of (a) *Cuprum metallicum* and (b) *Aconitum napellus*

of electrons from the hydroxyl group provides an electron-rich environment at the surface of the copper nanoparticles, assigning the negative zeta potential of the drug, which is evident from the Dynamic Light Scattering (DLS) study. The charged drug molecule interacts with the polar head group where it gets adsorbed. The adsorption process of the drug onto lipid molecules is in general favored due to the high aspect ratio of the nano-size of the drug.

The Raman spectra study of the drugs revealed that there is no change in the chemical structure of the drug due to potentization.

EFFECT OF POTENCY OF HOMOEOPATHIC MEDICINE ON MEMBRANE FLUIDITY

Despite much research on the effect of homoeopathic medicines both *in vivo* and *in vitro*, there has been little reports on the effect of these medicines on the cell membrane, a primary site of action of most medicines. Knowledge of interaction between the drug and the membrane is crucial for explaining a drug's activity, selectivity and toxicity. These interactions may be nonspecific such as van der Waals force, electrostatic interactions and hydrogen bonds.

The fluid mosaic model of lipid bilayer structure of the membrane gets disrupted significantly by both hydrophobic and hydrophilic types of probes,[24] which disrupts lipid–lipid interactions amongst the head group and/or acyl tails. This results in changes in lipid bilayer phase behavior, related to the degree of lipid ordering and bilayer viscosity.[25-28]

Membrane anisotropy, which is inverse of fluidity, can be measured[29] by incorporating the fluorescence polarization probe 1,6-diphenyl-1,3,5-hexatriene (DPH) in the liposomal membrane of dipalmiyoyl phosphatidyl choline, the well accepted model for the real biological membrane. The steady-state fluorescence anisotropy is related to the fluorescence intensity:

$$r = (I_1 - I_2)/(I_1 + 2I_2),$$

where I_1 and I_2 are the vertical and horizontal components of the 428 emission band of DPH in the liposome, while the sample is being excited at 360 nm. This is a standard procedure used to measure the effect of external agents, like chemicals and drugs, on membrane fluidity.

Effect of Potency of Drug *Aconitum napellus* on Membrane Fluidity

Bhandary *et al*.[13,15] studied the effect of *A. napellus* on the microviscosity of the membrane and the influence of drug potency. Their work yields interesting results and indicates an increase in the membrane rigidity with increasing potency of the drug. An explanation for this effect had been sought at the molecular level, based upon the dug–lipid interaction. From the experimental data, Van't Hoff enthalpy change has been calculated, and an estimate made of the fraction of motionally restricted lipid molecules. They observed that with an increase in potency, the membrane fluidity decreased, suggesting more penetration of the drug into the membrane [Figure 4 A]. This can be taken as an indirect evidence that the initial aggregated structure of the drug decreased in size with potentization, leading to nanoparticle formation of smaller dimensions, which facilitated enhanced membrane penetration and decreased membrane fluidity.

As the drug induces change in the fluidity profile in the liposomal membrane and also the phase transition temperature, the enthalpy change associated with this process also changes. With this

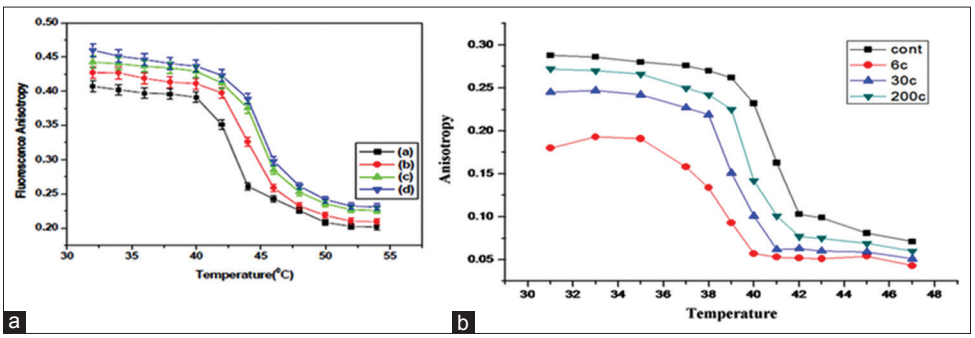

Figure 4: (A)Temperature-dependent fluorescence anisotropy values: (a) liposomal membrane of dipalmiyoyl phosphatidyl choline (10-4 M), (b) with drug *Aconitum napellus* of potency 6C, (c) with drug of potency 30C, and (d) with drug of potency 200C incorporated in liposomal membrane. (B) Effect of potency of drug *Cuprum metallicum* on membrane fluidity

perspective, we have calculated Van't Hoff enthalpy change associated with the phase transition in cases of drug-free and drug-incorporated liposomal membrane using the method of Marky and Breslauer.[30]

Following the method of Houbre *et al*.,[31] the number of drug bound lipid molecules was calculated from the fluorescence anisotropy data.[13] The value of χ, which is the fraction of motionally restricted lipid molecule, is indicated in Table 2.

Using the same liposomal membrane system, Ghosh *et al*.[12] have reported their study on the effect of potentization of the hydrophilic homoeopathic drug *C. metallicum* on the phase profile of the liposomal membrane. Here, the study shows that the fluidity of the microenvironment of the fluorescent probe increases for a lower potency of the drug, shifting the phase transition temperature to a lower value [Figure 4B]. For higher potencies, the effect is less significant. The difference in effect for the two drugs arises due to the diffference in nature of the two drugs: *A. napellus* being hydrophobic penetrates directly in the membrane, while *C. metallicum*, being hydrophilic in nature interacts with the head group of the liposomal membrane and rotates the lipid head group to create a channel and enters into the membrane interior.[24]

Figure 4B shows that incorporation of the drug has affected the membrane fluidity, and at potency 6C the fluidization is maximum. The effect is less significant when the potency is higher. Here the phase transition temperature has shifted from the higher value of the control to the lower values. Also here χ, the fraction of motionally restricted lipid molecules, decreases with the size reduction of drug particle [Table 3].

The size of the drug particle was measured from DLS study.[12] Figure 1 shows that the size of the particle is in the nano-range and it decreases with the increase in potency [Table 3]. HRTEM images also support this observation of the presence of nanoparticles of drug, their spherical shape and crystalline nature, and their decrease in size with increase in potency of the drug [Figure 1]. Change in Van't Hoff enthalpy ΔH_{Tm} is equal to the amount of heat required for each cooperative unit to undergo the phase transition. In this case, the value associated with the gel to liquid crystalline phase transition in the liposomal membrane has been calculated for each potency [Table 3].

Table 2: Effect of potency variation of drug *A. napellus* on phase transition temperature, Van't Hoff enthalpy change, and fraction of motionally restricted lipid molecules in the drug-incorporated liposomal membranes

Aconite dilutions (incorporated into liposomal membrane)	Phase transition temperature (T_m °C)	Van't Hoff enthalpy change (in kcal/mol)	Fraction of motionally restricted lipid molecules
0	42.0	124.68	0
6C	44.0	127.39	0.02
30C	44.6	126.79	0.02
200C	45.0	127.71	0.04

Table 3: *C. metallicum*-incorporated liposomal membrane

Sample	Phase transition temperature (T_m)	Van't Hoff enthalpy (ΔH_{Tm})	Motionally restricted lipid molecules (χ)	Size (nm) from DLS study (d)
Control	40.75	195.59	0	0
6C	38.54	181.28	0.327	13.5-18.5
30C	39.06	233.74	0.085	1.5-1.7
200C	39.7	235.37	0.016	0.621

ΔH_{Tm}: Van't Hoff enthalpy change; χ: Ratio of motionally restricted lipid molecules; d: Size of particle as measured by DLS: (Dynamic light scattering)

The decrease in size of the drug particle with increase in potency helps the drug particle to penetrate within the membrane and affect the membrane anisotropy.[12] The electrostatic interactions perturb the existing longitudinal and lateral order of the membrane lipids, thereby inducing packing stress, which is balanced by the induction of tilt and kink in the bilayer core. This results in decrease in the values of anisotropy and the phase transition temperature. The hydrophilic probe generates a hydrophilic hole around the probe[24] in the hydrophobic moiety inside the bilayer, which in turn decreases the anisotropy further.

At lower dilution of the drug (6C), the change in anisotropy is greater as more drug particles are available for interacting with the lipid head group, which is obvious from the high value of the χ value [Table 3]. As at higher dilution, fewer drug particles are available to interact with the lipid head groups, and the change in anisotropy of the membrane moiety becomes less. This is also supported from the fact that the χ value decreases with increase in dilution. The optimal amount of anisotropy in health and disease cannot be determined from this study as this was performed

on a model membrane system, which is much simpler than the more complex real membrane.

The shape and size of the nanoparticles play a significant role on membrane internalization. The size-dependent endocytosis as conducted by Zhang *et al*.[32] shows that spherical particles of similar size are taken up 500% more than the rod-shaped particles, as greater membrane wrapping time is required for elongated particles. The data obtained from the DLS and the HRTEM studies show that the size of the nanoparticles of the drug are in the region 0.5–20 nm and are spherical in nature, making the drug membrane interaction significant.

Comparison of change in Van't Hoff enthalpy for three dilutions [Table 3] shows that in the case of 6C the values of anisotropy is minimum [Figure 4] and the associated change in Van't Hoff enthalpy is also minimum. For the other two dilutions, values of anisotropy increase and so do the values of $\Delta H_{Tm.}$

From the DLS and HRTEM studies, we come to the conclusion that homeopathic potentization, which is dilution followed by succussion, changes the mean size of nanoparticles of the homoeopathic drug. The reduction in size modulates the anisotropy of the liposomal membrane and the UV–vis and FTIR spectra.

Our experimental result on the effect of the homeopathic drug *C. metallicum* on liposomal membrane fluidity compares well with that obtained with copper nanoparticles at low concentration, confirming that Homoeopathy is basically a nanomedicine.[28]

The increase in potency of homeopathic drug with dilution had been an unsolved problem for quite some time. Our experimental findings and interpretation thereof, being very fundamental in nature, indicates a solution to the puzzle that had been confronting scientists for more than two centuries.

And once again, we are reminded of the advice by Bell[33] that "rather than taking a defensive stance in presenting Homoeopaths to sceptical medical colleagues, homeopaths can begin to explain their field in contemporary scientific technology."

HOMOEOPATHIC MEDICINE TO HOMOEO-TECHNOLOGY

We have taken this property of nanoparticle formation of homoeopathic medicine one step further by utilizing them in technological applications.[34]

HOMOEOPATHY MEDICINE *ZINCUM OXYDATUM* AS AN AGENT FOR THERMOVOLTAGE GENERATION

Harnessing solar energy using inexpensive techniques is an important challenge, and newer concepts are being developed for solar to electrical energy conversion. In search of newer materials for efficient conversion of solar energy into electrical energy, several nanomaterials have been engineered.[35] In order to improve the performance of solar cells and make it efficient, a very novel idea of using homeopathic medicines is hit upon.

Using a homoeopathic-medicine *Zincum oxydatum*, thermo-voltage has been generated in a specially designed electro-chemical cell.[36] Maximum voltage generated was found to increase with potency of the medicine. Efficiency of the cell with the medicine at potency 30C at 40°C is ~0.39%. With a similar cell using synthetic Zinc oxide nanoparticle, efficiency was found to be ~0.37%[37] [Figures 5-7].

Homeopathic Medicine *Ferrum metallicum* to Improve Electrical Properties of the Polyvinylidene Fluoride Film

Electroactive polymer films currently have become the topic of intense global research work for their versatile applications in electronic industry. These films have very good piezoelectric, pyroelectric, ferroelectric, dielectric, and electro-optic properties among others and due to their high flexibility, simple fabrication processe, and nontoxicity, they have

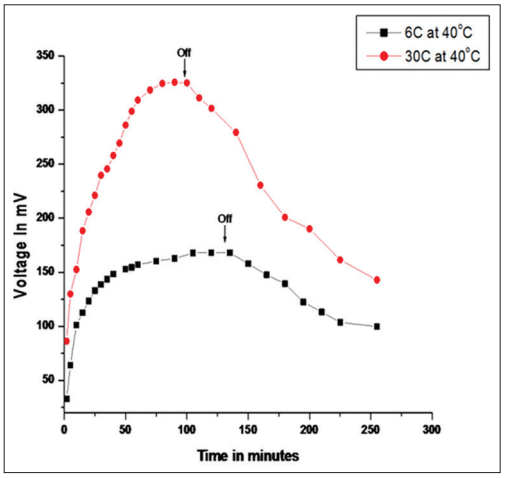

Figure 5: Growth and decay curve of thermovoltage generation using *Zincum metallicum* at potency 30C

become an alternative for traditional ferroelectric ceramics.[38]

Out of all these polymers, polyvinylidene fluoride (PVDF) and its copolymers are selected and their characteristic properties have been manipulated manifold by incorporating suitable fillers.[39] In the search for suitable nontoxic filler, we have used for the first time the homoeopathic medicine *F. metallicum*[40] [Figure 8].

Our experiments have shown that incorporation of the homoeopathic medicine *F. metallicum* at different potencies of the medicine has increased the dielectric constant [Figure 9a] and decreased the dielectric loss [Figure 9b]. The AC conductivity of the electroactive polymer film (PVDF) also increases with frequency [Figure 9c]. The changes in values of all these three physical properties increase with increase in potency of the medicine.[40]

This phenomenon of increment of dielectric constant by incorporating nanomodifiers can be explained by Maxwell–Wagner–Sillars interfacial polarization effect, which appears in heterogeneous medium consisting of different phases with different permittivity and conductivity due to accumulation of the charges at the interfaces. In the film doped with *F. metallicum* at 200C, the nano-iron particles are well separated from each other with no such effective interaction between them and are embedded in good and homogeneously distributed polymer matrix [Figure 8]. So the interfacial area per unit volume of nanoparticles increases. This improves the average polarization associated with the particles and the coupling between the neighboring grains, resulting in the significant enhancement of dielectric constant as well as significant decrement of tangent loss.

For films doped with *F. metallicum* at potencies 6C and 30C, the grain size of iron particles are of bigger form and agglomerated which is embedded in the polymer matrix. So the interfacial area per unit volume as well as the interparticle distance decreases. This decreases the average polarization associated with the particles resulting in the further decrement of dielectric constant and AC conductivity as well as increment of tangent loss [Figure 9a-c].

At a time when electroactive polymer films are gaining world-wide attention, this simple fabrication and nontoxic method will make the homoeo-polymer filler a suitable alternative and hence the outcome of this experiment is of great significance.

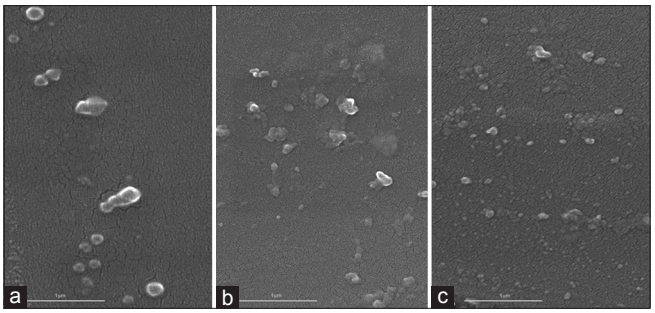

Figure 6: Scanning electron microscopy picture of *Zincum oxydatum* at 3 potencies: (a) 6C, (b) 30C, and (c) 200C

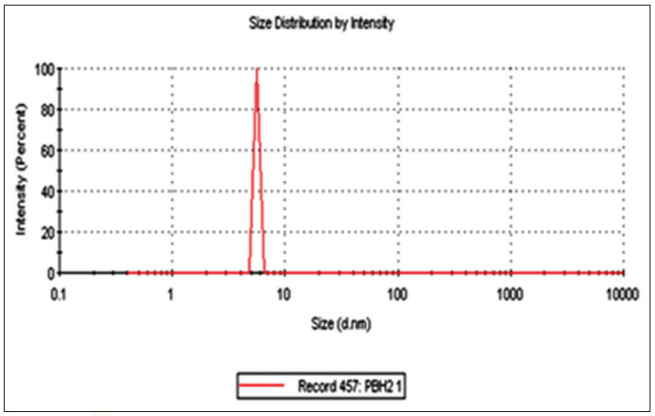

Figure 7: Particle size distribution from dynamic light scattering of *Zincum oxydatum* at 30C potency[36]

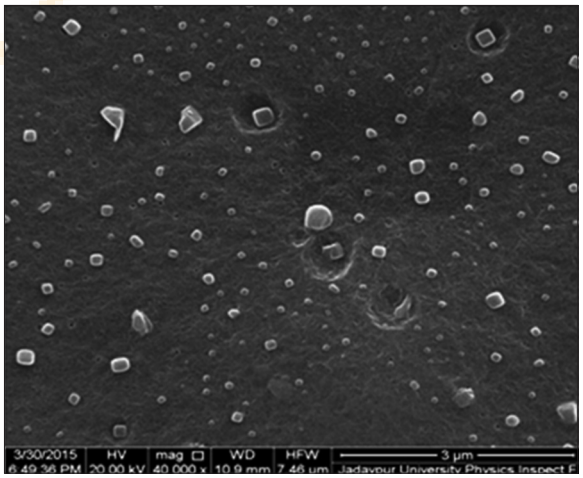

Figure 8: The scanning electron microscopy of polyvinylidene fluoride film doped with *Ferrum metallicum* at 200C

The dielectric constant of all films doped with *F. metallicum* at different potencies is higher than the pure polymer throughout the frequency range 20 Hz–2 MHz. The film doped with *F. metallicum* at 200C potency has the highest dielectric constant. This enhanced dielectric behavior is highly desirable for high-performance capacitors. The tangent loss of *F. metallicum* at 200C potency-doped polymer

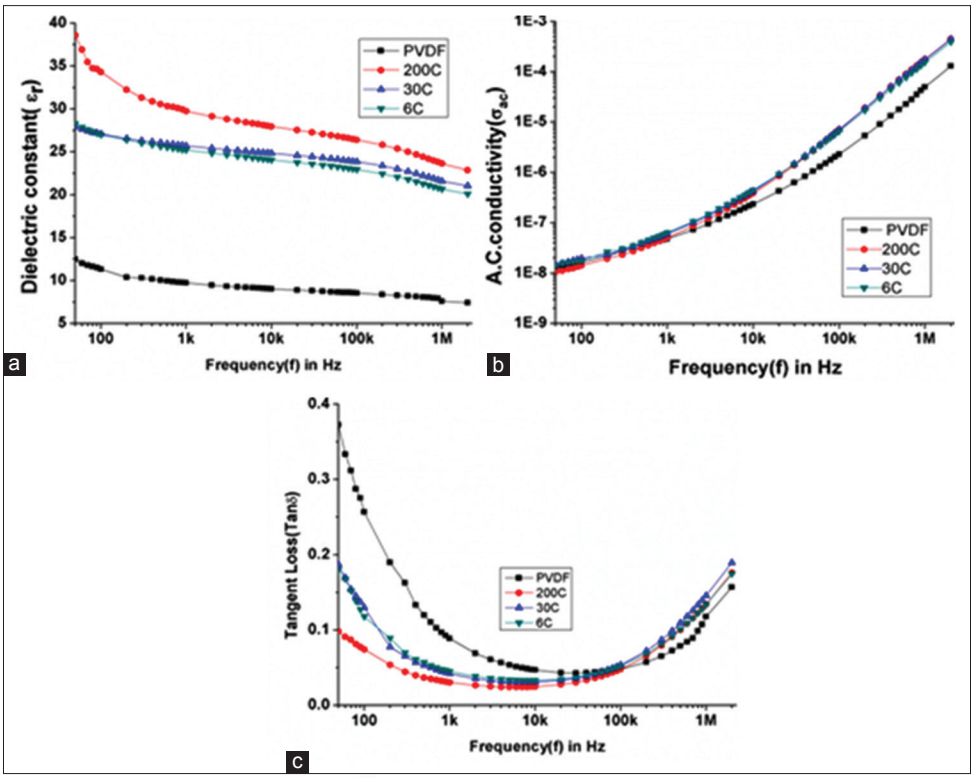

Figure 9: (a) Variation of dielectric constant. (b) Variation of tangent loss. (c) Variation of AC conductivity with a frequency of Polyvinylidene fluoride film doped with *Ferrum metallicum* at different potencies

film is the lowest in that whole frequency range which is very much desirable in response to low loss electronic devices. The AC conductivity also increases with frequency for all polymer films doped with *F. metallicum* due to the presence of mobile metallic contents in the polymer composites.[40]

Thus, the pure polymer film which has comparatively low dielectric constant has been modified into materials with enhanced dielectric constant and comparatively low tangent loss by making a composite with homeopathic nanomedicine *F. metallicum*. The polymer film doped with *F. metallicum* at 200C potency can be used as a high dielectric material for the fabrication of high charge storing multilayer capacitors and can be a promising candidate for electronic industries.

CONCLUSION

Using several homoeopathic medicines, it has been shown that with an increase in potency the drug particle size decreases achieving nano-dimension. Konovalov has concluded that nanoassociate formation is a clue to understanding the behavior of highly diluted aqueous solution.[41]

Because of their reduction in size, the nanoparticles modulate the membrane fluidity, which affects membrane-based functions, including permeation of drugs through the membrane.

For the first time, we have successfully utilized the nanoparticle behavior of homoeopathic medicine in some technical applications, viz. for thermovoltage generation[36] and for improvement of dielectric properties of electroactive polyvinyl film PVDF.[40]

The standard methods used to engineer nanoparticles for technical applications are labor-intensive, expensive, and often hazardous. The great advantages of using homoeo-nanoparticles are that they are eco-friendly, easily available, and are cost effective.

Thus, by using homoeopathic medicine in technology, we have connected the important, old, un-quantifiable effects with the latest quantifiable technology and opened up an era of applications with many possibilities.

Acknowledgment

The work has been done in technical collaboration with the Central Council for Research in Homoeopathy, New Delhi. Equipment facilities were

obtained from different departments of Jadavpur University. Drugs were gifted from the manufacturer, Hahnemann Publishing Company, Kolkata, India. Stimulating discussion with Dr. D.S. Bhar is thankfully acknowledged.

All the data presented here are from experiments performed by us. The unpublished results are taken from our communicated papers.

Stimulating discussions with Subrata Kar is thankfully acknowledged. The author acknowledges, most happily, the help received from her students and fellow coworkers.

Financial Support and Sponsorship

The author acknowledges the support of Central Council for Research in Homoeopathy, New Delhi.

Conflicts of Interest

There are no conflicts of interest.

REFERENCES

1. Davenas E, Beauvais F, Amara J, Oberbaum M, Robinzon B, Miadonna A, *et al.* Human basophil degranulation triggered by very dilute antiserum against IgE. Nature 1988;333:816-8.
2. Betti L, Trebbi G, Olioso D, Marzotto M, Bellavite P. Basic research in homoeopathy and ultra-high dilutions: What progress is being made? Homoeopathy 2013;102:151-4.
3. Khuda-Bukshsh AR. Search for a molecular mechanism of action of the potentised homeopathic drugs in living organisms. Int J High Dilution Res 2012;11:147.
4. Sukul NC. Experimental evidence in support of the biological effects and physical basis of homeopathic potencies. Int J High Dilution Res 2012;11:142-3.
5. Khuda-Bukhsh AR. Current trends in high dilution research with particular reference to gene regulatory hypothesis. Nucleus 2014; 57:3-17.
6. Anick DJ, Ives JA. The silica hypothesis for homoeopathy: Physical chemistry. Homoeopathy 2007;96:189-95.
7. Elia V, Napoli E, Germano R. The "memory of water": An almost deciphered enigma. Dissipative structures in extremely diluted aqueous solutions of the homeopathic medicine. Homoeopathy 2007;96:163-9.
8. Demangeat JL. Nanosized solvent superstructures in ultramolecular aqueous dilutions: Twenty years' research using water proton NMR relaxation. Homoeopathy 2013;102:87-105.
9. Elia V, Marrari LA, Napoli E. Aqueous nanostructures in water induced by electromagnetic fields emitted by EDS. J Therm Anal Calorim 2012;107:843-51.
10. Yinnon TA, Yinnon CA. Electric dipole aggregates in very dilute polar liquids: Theory and experimental evidence. Int J Mod Phys B 2011;25:3707-43.
11. Maity T, Ghosh D, Mahata CR. Effect of dielectric dispersion on potentised homeopathic medicines. Homoeopathy 2010;99:99-103.
12. Ghosh S, Chakraborty M, Das S, Basu R, Nandy P. Effect of different potencies of nanomedicine *Cuprum metallicum* on membrane fluidity – A biophysical study. Am J Homeopath Med 2014;107:161-9.
13. Bhandary S, Das S, Basu R, Bhattacharyya S, Nandy P. Effect of *Aconitum napelles* on liposomal microviscosity. Int J Emerg Technol Sci Eng 2011;3:1-5.
14. Shah R. Scientific method of preparing homeopathic nosodes. Indian J Res Homeopath 2014;8:166-74.
15. Nandy P, Bhandary S, Das S, Basu R, Bhattacharya S. Nanoparticles and membrane anisotropy. Homoeopathy 2011;100:194.
16. Chikramane PS, Suresh AK, Bellare JR, Kane SG. Extreme homeopathic dilutions retain starting materials: A nanoparticulate perspective. Homoeopathy 2010;99:231-42.
17. Upadhyay RP, Nayak C. Homoeopathy emerging as nanomedicine. Int J High Dilution Res 2011;10:299-310.
18. Chikramane PS, Kalita D, Suresh AK, Kane SG, Bellare JR. Why extreme dilutions reach non-zero asymptotes: A nanoparticulate hypothesis based on froth flotation. Langmuir 2012;28:15864-75.
19. Frye J. Research update. Am J Homeopath Med 2013;106:35-6.
20. Chakraborty M, Ghosh S, Das S, Basu R, Nandy P. Effect of different potencies of nanomedicine Aconitum napelles on the spectral and antibacterial properties. International Journal of Innovativee Research in Science, Engineering and Technology 2015;4:6861-67.
21. Rao ML, Roy R, Bell IR, Hoover R. The defining role of structure (including epitaxy) in the plausibility of homoeopathy. Homoeopathy 2007;96:175-82.
22. He YQ, Liu SP, Kong L, Liu ZF. A study on the sizes and concentrations of gold nanoparticles by spectra of absorption, resonance Rayleigh scattering and resonance non-linear scattering. Spectrochim Acta A Mol Biomol Spectrosc 2005;61:2861-6.
23. Coates J. Interpretation of infrared spectra, a practical approach. In: Meyers RA, editor. Encyclopedia of Analytical Chemistry. Chichester: John Wiley and Sons Ltd.; 2000. p. 10815-37.
24. Liu F, Wu D, Kamm RD, Chen K. Analysis of nanoprobe penetration through a lipid bilayer. Biochim Biophys Acta 2013;1828:1667-73.
25. Bhandary S, Basu R, Da S, Nandy P. Effect of some statin group of drugs on the phase profile of liposomal membrane – A fluorescence anisotropy study. Phase Transit 2009;82:821-30.
26. Ghosh AK, Basu R, Nandy P. Lipid perturbation of liposomal membrane of dipalmitoyl phosphatidylcholine by chloroquine sulphate – A fluorescence anisotropic study. Colloids Surf B Biointerfaces 1995;4:1-4.
27. Ghosh AK, Pore N, Basu R, De S, Nandy P. Lipid perturbation by corticosteroids: An anisotropic study. Colloids Surf B Biointerfaces 1996;7:65-8.
28. Bhandary S, Sultana P, Basu R, Das S, Nandy P. A study on the modulation of the phase behavior of lipid aggregates – Effect of some metal nanoparticles. Adv Sci Eng Med 2011;3:213-8.
29. Shinitzky M, Barenholz Y. Fluidity parameters of lipid regions determined by fluorescence polarization. Biochim Biophys Acta 1978;515:367-94.
30. Marky LA, Breslauer KJ. Calculating thermodynamic data for transitions of any molecularity from equilibrium melting curves. Biopolymers 1987;26:1601-20.
31. Houbre D, Schindler P, Trifilieff E, Luu B, Duportail G. Selectivity of lipid-protein interaction with myelin proteolipids PLP and DM-20. A fluorescence anisotropy study. Biochim Biophys Acta 1990;1029:136-42.
32. Zhang XH, Maeda N, Craig VS. Physical properties of nanobubbles on hydrophobic surfaces in water and aqueous solutions. Langmuir 2006;22:5025-35.
33. Bell IR. Homoeopathy as systemic adaptational nanomedicine: The nanoparticle cross adaptation sensitization model. Am J Homeopath Med 2012;105:116-30.
34. Nandy P. Novel Application of Homoeopathy: Presented at the Global Homoeopathy Summit on Recent Advances in Scientific Research, Mumbai, India; 11th-12th April, 2015.
35. Kamat PV. Meeting the clean energy demand: Nanostructure architectures for solar energy conversion. J Phys Chem C 2007;111:2834-60.
36. Bandyopadhyay P, Nandy P, Basu R, Bhar DS, Das S. Effect of dilution on thermovoltage generation using homeopathic nanomedicine

Zincum oxydatum. Int J Innov Res Sci Eng 2015;3:225-30.
37. Mondal A, Basu R, Das S, Nandy P. Heat induced voltage generation in electrochemical cell containing zinc oxide nanoparticles. Energy 2010; 35:2160-3.
38. Nalwa H. Ferroelectric Polymers: Chemistry, Physics and Applications. New York: Marcel Dekker; 1995.
39. Thakur P, Kool A, Bagchi B, Hoque NA, Das S, Nandy P. *In situ* synthesis of $Ni(OH)_2$ nanobelt modified electroactive poly (vinylidene fluoride) thin films: Remarkable improvement in dielectric properties. Phys Chem Chem Phys 2015;17:13082-91.
40. Pal BK, Basu B, Bhar DS, Das S, Nandy P. Effect of potency of homeopathic nano medicine *Ferrum metallicu*m on poly (vinylidene fluoride) film – Significant improvement of the electrical properties; 2015 Communicated.
41. Konovalov AI. The formation of nanosized molecular assembles in highly diluted aqueous solution. Her Russ Acad Sci 2013; 83:513-9.

समीक्षा लेख

एक काय–चिकित्सक के दृष्टिकोण से होम्योपैथी में आधारभूत अनुसंधान की समीक्षा

पापिया नंदी

अंतर्विषयक अनुसंधान एवं शिक्षा केंद्र, कोलकाता, पश्चिम बंगाल, भारत

सार

होम्योपथी औषधि विश्व की सर्वाधिक व्यवहारित वैकल्पिक चिकित्सा पद्धतियों में से एक रही है। हालांकि, तनूकरण एवं उसके बाद आस्फालन (जिसे एक–साथ शक्तिवर्धन कहा जाता है) से होम्योपैथिक औषधि की शक्ति बढ़ती है और इस तथ्य ने समग्र स्तर पर वैज्ञानिक समुदाय के समक्ष चुनौतियां प्रस्तुत की हैं। हमारे एवं अन्य द्वारा कुछ ही समय पहले प्रस्तुत एक परिकल्पना के अनुसार, शक्तिवर्धन के प्रक्रम के कारण, घटक कणों का आकार घटता जाता है और अंततः नैनोविमा तक पहुंच जाता है। शक्ति में वृद्धि के साथ आकार में इस कमी को स्केनिंग इलेक्ट्रॉन सूक्ष्मदर्शी एवं गतिक प्रकाश प्रकीर्णन अध्ययनों द्वारा सत्यापित किया जा चुका है। शक्ति में हुई वृद्धि, झिल्ली की तरलता पर इसके बढ़े हुए प्रभाव के रूप में अभिव्यक्त होती है। शक्ति में हुआ परिवर्तन पराबैंगनी–दृश्य स्पेक्ट्रम, फोरियर ट्रांसफॉर्म अवरक्त स्पेक्ट्रम एवं रमन स्पेक्ट्रम पर भी अपनी विशिष्ट छाप छोड़ता है। हमने होम्योपैथिक औषधियों के नैनो–विमीय गुणों को लेकर कई तकनीकी अनुप्रयोगों में उन्हें लाने की दिशा में एक कदम और बढ़ा दिया है। और ऐसा करने में, हमने महत्वपूर्ण, प्राचीन, अमापनीय प्रभावों को नवीनतम, मापनीय प्रौद्योगिकी से जोड़ दिया है तथा अधिक संभावनाओं वाले अनुप्रयोगों के दौर को आरंभ कर दिया है।

मुख्य शब्दः विषमदिशता, अभिलक्षणन, होम्यो–नैनोऔषधि, होम्यो–प्रौद्योगिकी, शक्तिवर्धन

Revisión de la investigación básica en homeopatía desde el punto de vista del físico

RESUMEN

La medicina homeopática es uno de los métodos terapéuticos alternativos más ampliamente practicados en el mundo. Sin embargo, el hecho de que la potencia del medicamento homeopático aumenta conforme incrementa su dilución seguida de la sucusión (lo que, en conjunto, se denomina potenciación), ha dado muchos quebraderos de cabeza a la comunidad científica. Una hipótesis reciente, avanzada por nosotros y por otros autores, es que, debido al proceso de potenciación, se reduce el tamaño de las partículas constituyentes llegando finalmente a nanodimensiones. Mediante microscopía electrónica de barrido y estudios de dispersión lumínica dinámica, se ha verificado este descenso del tamaño con el aumento de potencia. El incremento de la potencia se manifiesta por el aumento del efecto en la fluidez de la membrana. El cambio de potencia también queda expresado en los espectros Ultravioletas Visibles, la espectrometría infrarroja de transformada de Fourier y el espectro de Raman. Nosotros hemos ido un paso más allá para llevar esta propiedad nanodimensional del medicamento homeopático e incorporarla en varias aplicaciones técnicas. De este modo, se han conectado los antiguos efectos importantes, no cuantificables con la tecnología cuantificable más avanzada, abriendo así una era de aplicaciones con más posibilidades.