

POLARIZED MICROWAVE AND RF RADIATION EFFECTS ON THE STRUCTURE AND STABILITY OF LIQUID WATER

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ABSTRACT:-

Starting with the most recent papers on the structure of water, among others, we have established first that liquid water can (and does) have many structures with distinctive properties. Next we establish that ultradilute (≈ 1 ppm) aquasols are changed both in structure and dramatically in properties. Then we review briefly the considerable body of work, largely unknown to materials scientists, of the effects of EM radiation on water. Our own results cover separately microwave (2.45 GHz) and RF (13.56 MHz) radiation. We establish the plausibility of such changes by referring to extensive earlier work over 10 years at Penn State which has shown that single mode (2.45 GHz) microwave radiation can render even very strongly bonded crystalline solids totally amorphous in a few seconds. Detailed Raman spectroscopy provides the data on major changes in the water structure including striking reduction in the main stretching modes. The times for relaxation of the structure at room temperature is at least in hours.

INTRODUCTION

The most important—to humankind—condensed matter phase on the planet by almost any measure is certainly liquid water. Yet materials scientists have largely ignored it. The term, “structure of water” has almost exclusively dealt with the **molecular** structure, and has been studied extensively by chemists since Lavoisier, Priestley and Faraday sorted out its composition. All such work is available in the indispensable, unique, continuously updated review by Martin Chaplin which summarizes masterfully the status of the huge amount of literature on this topic [1]. Go to <http://www.lsbu.ac.uk/water/chaplin.html>. Most of this monumental work deals with molecules with composition H_2O which do exist under various circumstances. Thousands of beautiful cartoons of innumerable monomer, oligomer and polymeric molecules are shown and discussed. However, materials scientists are not as interested in the constituent units (the molecules) like the bricks of a building, but the size and shape of the rooms, and the arrangement in space of the units within such. Chaplin himself has recently [2,3] provided two very useful reviews encompassing some of the latter also. Fig 1 shows first an enlightening summary of the density of the water in both the solid crystalline, and the liquid state. Since the first law of materials science says that properties are determined largely by structure, it is clear that the various polymorphs of crystalline ice increase in

density with pressure. What is striking is that liquid water follows the same pattern without the discontinuities of a first order transition. Indeed, it can be seen that the much researched glassy water shows roughly the same pattern. Figure 2 taken from E. Stanley's detailed review [3] on (glassy) water provides further data. The figure shows a schematic dependence on temperature of the isothermal compressibility, K_T , the specific heat at constant pressure, C_p , and the coefficient of thermal expansion, α_p . The solid line represents the behavior of water, while the dashed line indicates that of a typical liquid. Each of the three thermodynamic response functions is proportional to corresponding fluctuations in parameters such as entropy or volume. The anomalous thermodynamics of and fluctuations of liquid water are apparent above the melting temperature, T_m , and they become much more striking as one supercools below T_m . This is a striking contrast between water and typical liquids. The highly anomalous shapes of the property vs. P, T show that we have changes in structure of water and hence require higher order transitions — as would be expected—in the structure of liquid water. We note that the breaks in the many different properties are at several **different** temperatures, indicating that there are several structures of water in the 0-100°C range at 1 atm.

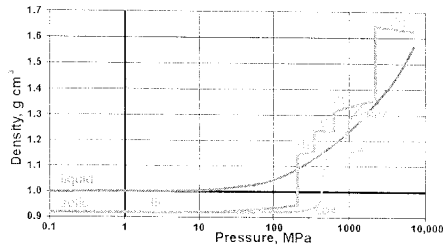


Figure 1: The density of liquid and solid water in relation to glassy amorphous ices.

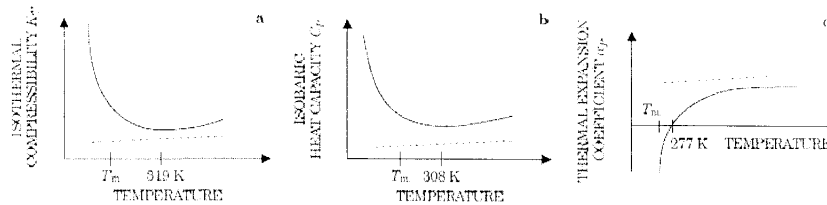


Figure 2 : Schematic dependence on temperature of (a) the isothermal compressibility K_T , (b) the constant pressure specific heat C_p , and (c) the coefficient of thermal expansion α_p . The behavior of water is indicated by the solid line; that of a typical liquid, by dashed lines. (Taken from Ref 3)

In a lengthy review Roy et al. [4] on the materials science perspective, on the same topic, have marshaled the arguments from the condensed matter physical chemistry evidence in liquids in general, especially in covalently bonded liquids. Vezzoli, Dachilles

and Roy [5] showed in the 1970's for the first time, that different thermodynamically stable phases of common liquids exist in modest P-T ranges. And recently Kawamoto [6] obtained data exactly analogous to these, in the same pressure range, showing at least one other **stable** liquid phase of water.

By analogy with the TEM structure of glasses, Roy et al. also supported their argument for the virtually certain existence of nanoheterogeneous liquid water. The different clusters of oligomers discussed for decades as being present in water, fit in well with such very extensive data on glasses. Roy et al. adduced a further thermodynamics argument towards phase separation (often metastable) in all non-ideal systems, as conducive to such heterogeneity. Thus, clearly the detailed extensive studies by Chaplin at the molecular level, and Roy et al.'s data from the property data, and thermodynamic and phase diagram approach provide a very solid base for building on a model of multi-structures for water.

Kinetics of change of water structures: "Memory of water"

A hundred year long controversy has persisted in the science community against the possibility of different 'structures' of waters surviving for any specific time periods - hours to years. Much of this derives from an extraordinary reaction to the term "homeopathy"—which in simple form says if water (at the beginning and end of any process) is chemically identical: it cannot have changed at all. Of course to a materials scientist this is a preposterous affirmation. Graphite and diamond being identical in composition, interconvertible nowadays in milliseconds, and the most different in properties one can imagine, are the existence thereon which destroys such an argument.

We demonstrate in this paper that among the various vectors that alter the 'structure of water' radiation plays a significant role as also the presence of second solid phase as in the case of ultradilute metallic sols. Recent work [7] on ultradilute (nano in both concentration and size) Ag-aquasols by Roy et al. demonstrated the role of the Ag-O-H₂O in detailed TEM and HRTEM, the extraordinary bactericidal effects. The nature of the liquid phase in such ultradilute colloids is of significant interest. Our detailed experimental approach to use the state of art spectroscopic techniques (FTIR, UV-VIS and Raman) proves invariably that the presence of colloidal particles 1- 30 ppm does indeed alter the structure and biological properties of water. Having established the importance of the structure of water on its properties we also examined the structure of many water and alcohol-based ultra dilute homeopathic remedies. The results show that such materials can be easily distinguished from the pure solvent and from each other using the above techniques [8]. Of course, this in no way establishes or denies the clinical efficacy of homeopathy.

Chaplin [2] arguing for the **possibility** of a memory of water, summarizes the strange reaction of many scientists to such concepts thus:

"Too often the final argument used against the memory of water concept is simply 'I don't believe it'. Such unscientific rhetoric is heard from the otherwise sensible scientists, with a narrow view of the subject and without any examination or appreciation of the full body of evidence, and reflects badly on them."

Previous Work on 'Radiation Effects on Water'

The general introduction has made the point of the certainty of different structures in liquid water (the irrelevance of the femtosecond vibration of O-H bonds and the survival of any particular H-O-H atoms as H₂O have been dealt with by Chaplin [1, 2]). There has been a substantial body of work on the "structuring" of water by radiation, certainly with 'memories' sufficiently long for confirmation in the laboratory. We now have multiple tools to evidence the sustained changes in the 'Structure of water' caused by extrinsic factors. The most dramatic effects of the ability of electromagnetic fields on condensed matter are, possibly, those demonstrated by Roy, Agrawal, Cheng et al. [9-12] on the radically different phase formation and direct decrystallization of many solids, including the most important phases used in the electronic industry viz. ferrites, barium titanates, and even elemental silicon. In these papers it has been shown that using separate E and H fields from 2.45GHz radiation in a single mode cavity, dramatic differences are found in the structure of solids as confirmed by XRD, SEM, TEM and Raman characterization of the results of exposure, between the electric and magnetic fields. What is most surprising is the ability of these vectored fields to convert **in the solid state**, crystalline phases to non-crystalline phases. The work presented here involves similar disruptions of the main bonding structure of condensed matter, in this case, liquid water.

Juliana Brooks [13-15] in a series of patents has presented extensive theoretical models and a general theory of transverse and longitudinal wave effects on matter and the phenomenon of "spectral catalysis". This general theory of resonant coupling of a specific frequency to specific bonds in condensed matter is a reasonable base merely for the plausibility of phenomena such as those reported in our earlier work [16]. Even earlier, among many others Colic and Morse [17] had shown the influence of resonant RF radiation on the gas-liquid interface and on aqueous suspensions and solutions [18]. Earlier work by Chibowski et al. on pH, conductivity and Zeta potential of various treated colloidal suspensions in water show residual oscillations even after the field's removal [19-23]. Higashitani et al. through a series of investigations have quantified the effects of magnetic fields in several papers dealing with the 'magnetic memory effect' [24]. Pach, Duncan and Roy et al. have shown the effect of magnetic fields on CaCO₃ crystal growth [25]. Tiller et al. showed the effect of about 100 Gauss DC fields on the pH [26] of specially preprocessed waters. It may be noted that none of the work presented dealt in any way with reactions remotely like **the dissociation of water into its constituent elements H₂ and O₂**.

EXPERIMENTAL SECTION

For all the experiments, reverse osmosis, deionised water, henceforth referred to as R/O DI water was used. Steve Sedlmayr designed the vectored microwave device with a special design of the glass vessel stationed on the antenna of the magnetron for water distillation to generate 'clean' water. The theoretical basis and experimental details of the design of the setup were published elsewhere [27]. We describe here detailed analysis of the microwave distilled water employing chemical analysis and various spectroscopic techniques such as Ultra-Violet spectroscopy, FT- Infrared and extensive Raman spectroscopic studies. Intense calibration was carried out on each of the

instrument at every step in the experimental configuration and procedures. In the immersion Raman spectrometer, we used a Laser probe ($\lambda = 785 \text{ nm}$) with careful attention in positioning it into the sample container, and turning off the room lights eliminating all stray light during the entire course of the experimentation. Multiple Raman scans were carried out on each sample to ensure the reproducibility of the results.

RESULTS:

R/O water was allowed to distill in the presence of vectored 2.45 GHz microwave field. The microwave-distilled water was collected and allowed to cool to room temperature in most of the cases and then spectroscopically analyzed. Raman spectra of the microwaved water display striking changes in the main O-H stretch bond. Spectral analyses of the microwave water as a function of time was carried out isothermally at 21.6°C . Figure 3 shows the Raman spectra of microwave water showing that the changes in the structure are stable for at least up to 7 hours. Repeated analyses confirm the reproducibility of the results.

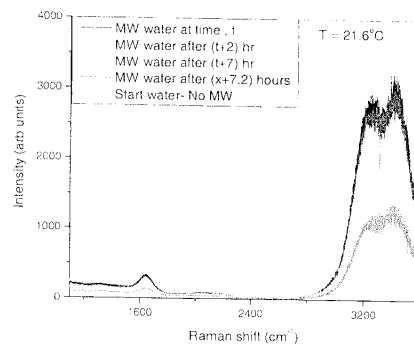


Figure 3: Raman spectra of microwave water measured at 21.6°C as a function of time. Note the time of relaxation for the structured-water is ~ 7.2 hours.

Effect of polarized 13.56 MHz radio frequency field on the structure of water

We present in this section the various effects of Polarized RF field on $\text{NaCl-H}_2\text{O}$ system. The equipment is described in the published patent applications of Mr. Kanzius (28-31) (other patents pending). Sample concentrations were varied from 0.1 to 30% of NaCl . The solution in a Pyrex test tube containing the salt-solution was held by means of a Teflon stand and was introduced into the RF cavity. In presence of the RF field the saline solutions ignites and 'burns' with an intense flame. Approximate power for most of our experiments was $\sim 300 \text{ W}$ as recorded by the output dial of the RF generator. The frequency of the RF was in the 13.56 MHz range. See, *e.g.*, exemplary Rudimentary attempts were made to measure the temperature of the flame; they agree with more

detailed measurements made by Dr. Steven Curley at M.D. Anderson Cancer Center, which place it at about 1800° C, in connection with their detailed cancer study [32, 33].

Figure 4 shows a very simple view of the variation of the flame size with the concentration of the solution. At lower NaCl concentrations, the intensity of the flame is lower. Immediately after the RF power is turned 'ON', the flammable gas can be ignited. The flame shuts 'OFF' as soon as the RF power is shut off. We also used concentrations close to the saturation with NaCl that produce somewhat larger flames as shown in Figure 5b. Samples of the NaCl solutions were analyzed for structure changes with UV-VIS and Raman spectrometry before and after exposure to the RF field (figure 4c). Furthermore, it is important to note that the Raman spectral analysis of the saline solutions before and after the combustion confirms that there are substantial structural changes. These are not discussed further in this context, but show that such changes in the structure of the liquid phase are also correlated with such radiation effects. Although 2.45GHz and 13.56 MHz are typical frequencies in the microwave and radio frequency region, it is interesting to note that unlike conventional fields, the radiation used in these experiments is 'vectorized' and hence alters the structure of water.

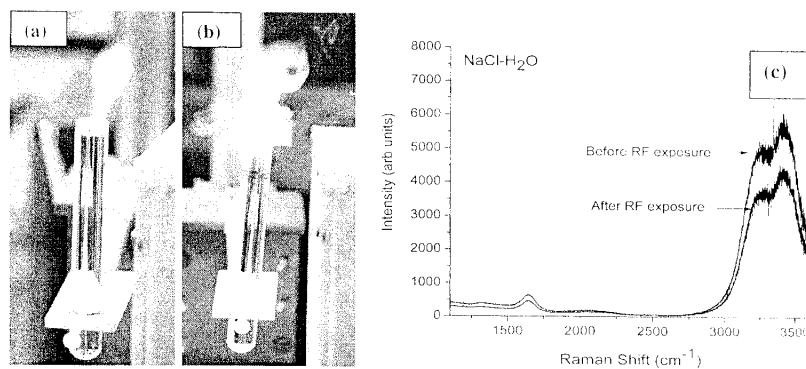


Figure 4 (a): Salt-water 'burning' in the presence of radiofrequency field at lower concentrations (b) higher NaCl concentrations (close to saturation) gives a brighter and much intense flame. (c) Raman spectra of the saline water before and after exposure to radio frequency. Note the change in the main O-H stretch band

SUMMARY:-

We have established with substantial evidence the influence of radiation – single mode 2.45 GHz Microwave radiation and polarized 13.56 MHz radiofrequency field can alter the structure of water and indeed totally destroy it in the later case. The time of relaxation for such changes is up to a few hours.

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