



# WATER STRUCTURE AND SCIENCE

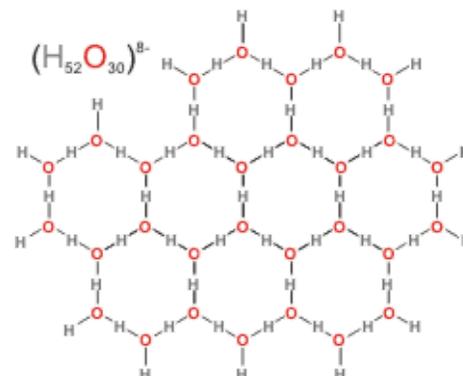
Martin Chaplin



## 'Polywater', Declustered Water and Other Waters

An assessment of polywater, declustered and anomalous water and other waters claimed to have unusual properties.

- ▼ Polywater
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### Polywater

One of the difficulties in putting forward novel ideas for the structure of water is that the scientific press has been mistaken before and prefers to shuffle forward in the almost known rather than take big steps into the less well known. The first water-related mischance, that the scientific literature fell into, concerned polywater (originally called anomalous water); a dense ( $> 1.3 \text{ g cm}^{-3}$ ) and viscous (20 x increased) form of 'polymeric' water that was reported, in the 1960s, to form in narrow ( $< 20 \text{ }\mu\text{m}$ ) capillaries [122]. The effects were later shown to be due to unforeseen impurities [123]. Some made unsubstantiated claims that stopcock grease and human sweat caused the original effects. However, some samples contained just silica, dissolution of which was not anticipated at that time as quartz vessels hold water without noticeable dissolution.<sup>d</sup> There were also delays in analyzing the polywater samples due to the minuscule volumes available ( $< \mu\text{g}$ ) and consequentially low silica contents ( $< 10^{-4} \mu\text{g}$  as then determined). Recognition that the properties of anomalous water were due to impurities was not before it had generated a considerable theoretical literature, both for and, less embarrassingly particularly early on, against. There was a positive outcome to this work in that it did stimulate much work on water at that time and showed the importance of materials dissolved from water containers. However, the episode seems to be usually remembered with discomfiture and probably reduced the publications concerned with water structure over the subsequent few years as many scientists avoided the area to avoid any similar pitfall. Since then, high-density liquid water has been verified to exist (at low temperatures [16]), but this is unrelated to any of the polywater samples. Polywater is still researched but on the basis of the properties of concentrated electrolyte silica condensates. Similar structures to 'polywater' have recently been introduced as support for Pollack's self-published 'Fourth phase of water' [2077] but these appear to be equally as unlikely as the original polywater and similarly ignore basic and well accepted scientific concepts. Likewise, an 'ice' prepared at room temperature by a substantial sequence of filtration through glass filters [2166]. appears to be due to dissolved impurities, that apparently were not subjected to proper analysis.<sup>d</sup>

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### I<sub>E</sub>

More recently, I<sub>E</sub> (ice formed by electric field forces) crystals (mm x 100 nm diameter) have been proposed to form around ions due to their electric field [124, 125a c e]. It is also proposed that these 'spherically symmetrical crystals' can be broken by shaking to seed further crystal formation, although this seems more likely to cause the loss of water molecules from the surface (peeling) rather than the release of fragments. The ions must be dilute ( $< 10^{-5} \text{ M}$ ) to prevent ions 'interacting' (reducing the electric field gradient) before crystals have time to form. The crystals are proposed to have 20% lower dielectric than water. These I<sub>E</sub> crystals are now thought to be completely artifactual with the term 'crystals' now being replaced by 'water clusters'. Even with this change, these theories have not been confirmed [125b d] and are not generally accepted and no ice phase is formed above 0 °C below 632 MPa. The presence of extensive hydrogen-bonded clusters in less-than-pure water containing additional hydrophobic solutes, however, is quite reasonable. [[Back to Top](#) ▲]

### HHO

Also recently promoted is 'HHO' a material produced from water by electrolysis that is supposedly different of the expected

electrolytic mixture.<sup>b</sup> This process apparently breaks the (inviolable) laws of thermodynamics and is backed by a paper that is full of scientific and numerical errors [938]. The claims for this material (that is, HHO) should be examined with great care, and are now correctly reported as totally erroneous [938b], although this is disputed [938c]. [[Back to Top ▲](#)]

## Neowater

An interesting development was the sale of 'neowater' ([water containing a minute amount of nano-sized, 10-50 nm, particles of barium titanate](#)) for various biotechnological processes. It was suggested that the particles organize the surrounding water and stabilize gaseous [nanobubbles](#) (more properly called nanocavities) resulting in the change in the liquid's properties. Scientific support for this was beginning to appear [1129, 1172], when the company ceased trading. [[Back to Top ▲](#)]

## Clustered and 'declustered' water

Very recently there has been an explosion of Internet sites and sales outlets concerned with 'declustered' water and its production. Generally these concern the promotion and sale of relatively expensive water preparations for their health benefit. These appear to be related to Lorenzen's 'microclustered' water [164] or Hayashi's 'microwater' [111]. Lorenzen prepared such water by passing steam across a magnetic field<sup>a</sup> (using magnetite), exposing it to light/radiation with a wavelength between 610 nm and 1 mm (preferably monochromatic at 640 nm) and adding materials such as 3 - 4 ppm metasilicate, up to 1% yeast cells and gas under pressure. His patents claim such water may be diluted by between  $10^3$  and  $10^{20}$  times. A similar product (Willards water) also uses silicates and surfactants [193], whereas 'Penta' water uses acoustical cavitation and oxygen saturation [496]. Hayashi prepared his water by electrolysis<sup>b</sup> using the reduced and oxidized streams for different purposes. Although cluster size can be determined from the shift in the  $^{17}\text{O}$  NMR resonance signal in line with its reduction with increasing temperature, in some cases it seems to have been determined by means of changes in the width (at half peak height) of the  $^{17}\text{O}$  NMR resonance signal from above 100 Hz to below 100 Hz. Other conditions being equal this width is expected to give a measure of the strength of the clustering as motionally-hindered water has faster relaxation kinetics and hence should give a greater  $^{17}\text{O}$  NMR resonance signal width (for example, the width also decreases with increasing temperature). However these samples are not pure water samples as they have high (supersaturated) gas concentrations and may contain other additives. The widths do not appear to change reproducibly as Hayashi reports a width for impure water of 105 Hz but Lorenzen reports the width for distilled and triple distilled water as higher at 130 Hz and 115 Hz respectively. Unfortunately the data reported by Lorenzen and Hayashi is sparse and does not include any statistical data or precise experimental conditions. Also there does not seem to be much other data reported in the literature concerning the effect of solutes on the width of this resonance or its reproducibility. Other uncontrolled factors, such as pH, will also have a major effect. Independent NMR analysis [1516] fails to confirm any useful correlation with structure. Nor is there any unanimity on what cluster size any reduction in the width might indicate. Other unanswered questions concern (a) whether it is the strength or extent of the hydrogen bonding that is important, (b) if extent is important, is it the mean number of hydrogen bonds each water molecule participates in or the mean cluster size of fully satisfied hydrogen bonded water molecules that is important, (c) if strength is important, is it the mean strength of all the bonds around a water molecule or only the strongest of these, (d) what is the effect of the distribution of hydrogen bond strengths (or extents), and (e) how long do any effects last<sup>c</sup>. More importantly, controlled clinical trials are lacking so that all sales patter extolling the health-giving virtue of such water involves the (scientifically irrelevant and basically biased) use of testimonials.

In the light of the increased promotion of 'special' water preparations, it is important to take notice that there are definite and proven health benefits from simply [drinking more water](#). [[Back to Top ▲](#)]

## Footnotes

<sup>a</sup> It has been shown that a high magnetic field has an insignificant effect on the equilibrium content of dissolved oxygen (< 0.3 mM at 20 °C under atmospheric conditions) but does significantly enhance its dissolution rate [176]. High electric fields ( $E \sim 10^9 \text{ V m}^{-1}$ ) reduce water's permittivity [616], which will increase the solubility of gases. Water may be supersaturated with oxygen ( $\sim 3\text{-}6 \text{ mM}$ ; equivalent to less than a breath of air in each liter of supersaturated water) under pressure. It should be noted that, left by itself, degassed water may take days to re-equilibrate with atmospheric gases and as even small amounts of dissolved gases are reported to have relatively large effects on the structuring of water [560], it is not unreasonable to suppose that artificially induced metastable conditions with higher gas content may last for

some time. Drinking of oxygenated water does give a transient moderate increase in serum ascorbyl radicals (with unknown consequences), an affect that disappears with regular consumption [422]. It will not, however, significantly add to the body's oxygen intake and has no apparent harmful or health-promoting effects [772]. Production of singlet oxygen ( $^1\text{O}_2$ ;  $^1\Delta_g^+$ , electrons paired in their n-antibonding molecular orbitals, cf.  $^3\text{O}_2$ , normal triplet oxygen,  $^3\Sigma_g^-$ , where two electrons are in equivalent but separate n-antibonding orbitals with the same unpaired spin) during processing may cause the dissolved peroxide concentration to increase via the water-catalyzed reaction ( $x \cdot ^1\text{O}_2 + 2\text{H}_2\text{O} \rightarrow (1-x) \cdot ^3\text{O}_2 + 2\text{H}_2\text{O}_2$ ) [1199] with possible consequential pharmacological effects. Interestingly singlet oxygen takes part in antibody-catalyzed water oxidation similarly producing triplet oxygen and hydrogen peroxide [624]. However, as the lifetime of the singlet oxygen is expected to be in the  $\mu\text{s}$  range when dissolved upwards towards 45 min in the (low pressure) gas phase, singlet oxygen molecules are not expected to remain in processed bottled water. [Back]

<sup>b</sup> At the electrolytic electrodes, water molecules are oriented, hydrogen bonds are broken and water's reactivity is increased. Anodic water (oxidizing, from the positive electrode) is biocidal and acidic and may contain  $\text{H}_2\text{O}_2$ ,  $\cdot\text{O}_2^-$ ,  $\cdot\text{OH}$ ,  $^1\text{O}_2$ , plus  $\text{HOCl}$  and  $\text{Cl}_2$  if  $\text{NaCl}$  is present. Cathodic water (reducing, from the negative electrode) has been used for washing and sanitizing [1277] and may be alkaline and contain  $\text{H}_2$ . Such  $\text{H}_2$  may form a supersaturated solution and be present in nanobubbles (10-1000 nm diameter nanocavities) stabilized by salts (for example,  $\text{Na}^+$  and  $\text{Cl}^-$ ) present [974]. Extensive electrolysis will also change the isotope ratio which may have an effect [424]. [Back]

<sup>c</sup> There is one report that magnetically treated water (also from the same laboratory, electromagnetically treated water) retains a significantly changed effect on fungal spore germination for at least 24 hours [174]; however other parameters (for example, reduced dissolved oxygen levels) may be responsible for such effects. Mechanically-induced hydrogen bond breakage, caused by shaking (succussion) when producing homeopathic solutions, has been reported to last for weeks [336]. [Back]

<sup>d</sup> It should be remembered that silica glasses dissolve in water to a small extent ( $\sim\mu\text{M}$ ) and that they cannot be washed clear of this dissolving material. The presence of dissolved material seems to catalyze this solution. On partial drying these solutions form water glasses. [Back]

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