Observations of polarised RF radiation catalysis of dissociation of H_2O–NaCl solutions

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The authors have shown that NaCl–H_2O solutions of concentrations ranging from 1 to 30%, when exposed to a polarised radiofrequency beam at 13·56 MHz at room temperature, generate an intimate mixture of hydrogen and oxygen which can be ignited and burned with a steady flame.

Keywords: Radiofrequency, Radiation effects, Water

Introduction

Over the last few decades there have been a series of claims of the possible changes in the 'structure' of water caused by the influence of electromagnetic fields.[1–7] The authors have recently summarised in detail their perspective on the structure of liquid water in several papers,[8–10] from the viewpoint of materials science as opposed to the molecular configurations emphasised in the chemical literature. Building on that materials science perspective, the authors present only some early observations in our laboratory repeating the serendipitous discovery of a new phenomenon by Kanzius, which point to a possible wider general scientific interest. The effect of radiofrequency (RF) photons on the structure and subsequent dissociation of water, to yield hydrogen and oxygen is suggestive of other applications.

The present paper originated in the senior author's viewing of the *YouTube* presentation[11] of television reporter, Mike O'Mara, at WKYC-TV3 in Cleveland, Ohio USA, which covered the discovery by Kanzius of the fact that 'sea water' when exposed to a 13·56 MHz polarised beam could then be ignited. The worldwide dissemination of the video attracted the intense attention of the lay public, business world and the scientific community. The latter was largely very sceptical and openly critical. Some individuals[†] within the science community could have been misled into thinking, possibly due to the tenor and enthusiasm of the TV announcer – that Kanzius had claimed that the effect, as described below, was generating more energy than that which was put into the system. No such claim has ever been made by him.

During a visit to the Kanzius' laboratory in Erie, PA USA, the senior author first confirmed the facts that had been reported in the TV report, namely a test tube of saline (NaCl concentration approximately equals that of sea water) in a clean Pyrex test tube with no electrodes, when exposed to a radiofrequency beam, dissociated the water into a mixture of hydrogen and oxygen, which when ignited by a match or a lighter could sustain the flame as seen in the TV reports as long as the water supply lasted.

Having confirmed the correctness of the observations, it was arranged to bring the radiation source to the microwave laboratory in the Materials Research Laboratory at Penn State to conduct a series of experiments of the authors' design, with their equipment and their solutions, on the phenomenon. The present brief paper presents the preliminary findings, dealing only with the facts of the earlier reports from Kanzius. Owing to the extreme interest in the data, the report reflects only the very first data obtained on the effects of RF radiation on NaCl solutions in the authors' laboratory.

Generation of hydrogen and oxygen via electrolysis and thermolysis has been studied previously.[12,13] Photo catalysis of various metal oxides has also been developed for water splitting with $\sim$50% quantum yield.[14] Meyer[15,16] had earlier designed a method for obtaining the release of fuel gas mixture including hydrogen and oxygen from water in which the water is processed as a dielectric medium in an electrical resonant circuit.

The effect of low energy (<1 eV) radiation on condensed matter has been studied during the past few decades; however, the literature is inconclusive and scarce. Bhalla *et al.*[17] very recently summarised various solid state changes achieved with 1–3 eV photons. Among many others, Colic and Morse[18,19] have shown the influence of resonant RF radiation on the gas/liquid interface and on aqueous suspensions and solutions.[20] Earlier work by Chibowski and Holysz[21] on pH, conductivity and Zeta potential of various treated colloidal suspensions in water shows residual oscillations even

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[†]It was perhaps this distortion that may have misled Philip Ball (who in fact had written a book on water and had shepherded our own unexpected similar microwave effects on solids past reviewers for *Nature*) in his rather unwarranted critique in *Nature* (published online Sept. 14, 2007.) No claims have ever been made by Kanzius of getting out more energy than was put in, etc. He only reported a unexpected observation, a forgotten art in modern laboratory practice, which could be pursued for a variety of possible applications. His observations, fortunately for science, unfortunately for his 'unscientific' critics who did not delve into the facts first, as in normal science, appear to be correct.

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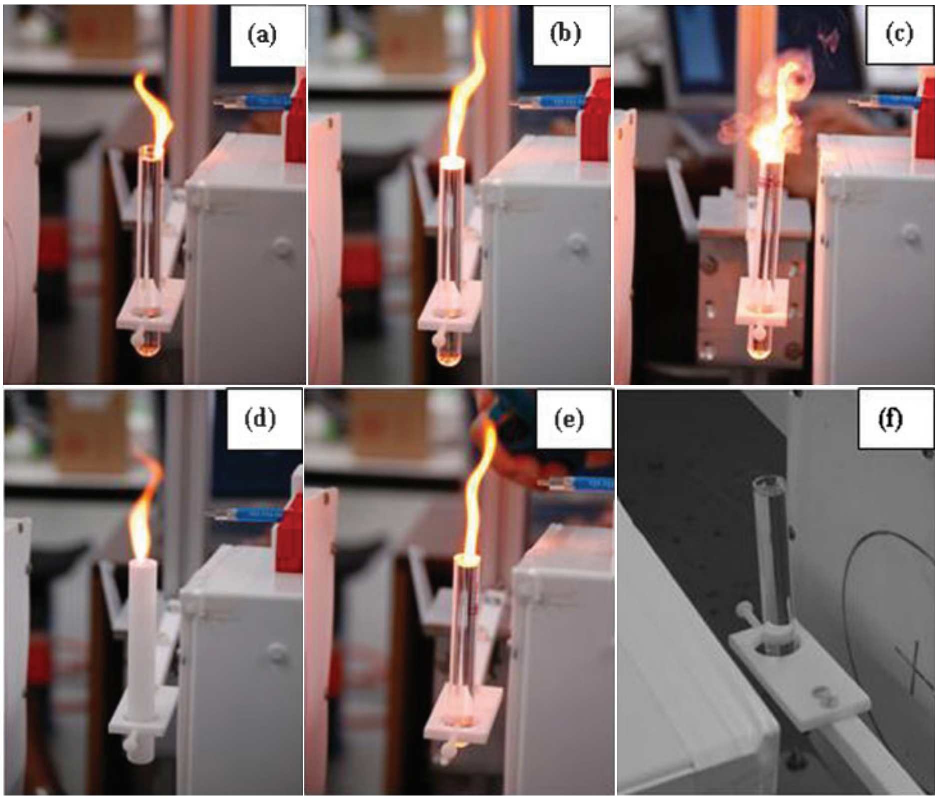


a 0·3%NaCl in Pyrex test tube; *b* 3%NaCl in Pyrex test tube; *c* 30%NaCl in Pyrex test tube; *d* 3%NaCl in PTFE tube; *e* 3%NaCl in Silica glass; *f* DI water either in silica glass or in PTFE (not shown here) (do not ignite)

1 Mixtures of various concentrations of NaCl and water combusting (when ignited) in presence of 13·56 MHz RF radiation

after the field's removal.[22–27] Higashitani *et al.*,[28] through a series of investigations, have quantified the effects of magnetic fields in several papers dealing with the 'magnetic memory effect'. Pach *et al.*[29] have shown the effect of magnetic fields on $CaCO_3$ crystal growth. Yamashita *et al.*[30] showed the effect of ~100 Gauss DC fields on the pH 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 liquid water into its constituent elements H_2 and O_2. This was first achieved by Faraday in 1831 using electric currents at voltages >1·23 V.

While most textbooks of thermodynamics and phase diagrams ignore any variables excepting P and T, it is, of course, well known that electric E and magnetic H fields are equally fundamental intensive variables. But these variables have largely been ignored by mainstream science, being regarded as de minimis, partly because of confusions in terminology and partly because of the imprecise use of the understanding of the kinetics of phase changes in condensed matter as distinct from molecular behaviour.

The most dramatic effects of the ability of weak electromagnetic fields on condensed matter are, possibly, those demonstrated by Roy *et al.*[31–34] on the radically different phase formation and direct decrystallisation of many solids, including the most important phases used in the electronic industry, namely ferrites, barium titanates, and even elemental silicon. In these papers it has been shown that using 2·45 GHz radiation in a single mode cavity, dramatic differences are found in X-ray diffraction (XRD), SEM, TEM and Raman characterisation of the results of exposure, between the electric and magnetic fields, and the ability to convert in the solid state these crystalline phases to non-crystalline phases. The work presented in the present paper involves a paradigm disrupting observation of the main bonding structure of a liquid phase.

Experimental

The equipment and its use in various medical institutions such as The University of Texas M.D. Anderson Cancer Center and The University of Pittsburgh Medical Center has been described in more detail in various presentations by these institutions. Approximate maximum power for most of our experiments was ~300 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 published patent applications of Kanzius[35–38] (other patents pending)). The authors prepared and processed a large series of samples and report in the present paper on the NaCl–H_2O system. Sample concentrations were varied from 0·1 to 30% of NaCl. The Pyrex test tubes containing the solution were held by means of a Teflon stand and were individually introduced into the RF cavity. The effluent gases at the top of the liquid surface were lit by means of a lighter. They typically sustained a continuous flame till the water was exhausted. Rudimentary attempts were made to measure the temperature of the flame – they agree with more detailed measurements made by Dr Curley at M.D. Anderson, which place it at ~1800°C.[39] Samples of the NaCl solutions were analysed for structure changes with ultraviolet visible spectrophotometry and Raman spectrometry before and after exposure to the RF field.

Results and discussion

Figure 1 shows a very simple view of the variation of the flame size with the concentration of the solution. At 3% (about sea water concentration) the results presented in the *YouTube* video are essentially confirmed. Larger flame sizes of about 4–5 inches are noted with higher concentrations of NaCl. Immediately after the RF power is turned 'ON', the flammable gas can be ignited. The flame shuts 'OFF' instantly as soon as the RF power is shut off. In the experiments to determine the effect of concentration, the authors were able to show that even 1 wt-%NaCl sustains a small flame continuously. Also used were concentrations close to saturation with NaCl that produce somewhat larger flames as can be seen in Fig. 1. A solid sustainable flame is obtained at all percentages of NaCl>1%. A small amount of Na is adventitiously introduced into the flame as little droplets; hence, the standard yellow colour in the flame (Fig. 2A).

Faraday in 1831 first established that water could be dissociated in a DC electric field with hydrogen emitted at the cathode and oxygen at the anode. To the best of the authors' knowledge, besides the use of the electric field current in some form, no other vectors have been found to dissociate liquid water into hydrogen and oxygen near room temperature. The use of weak electromagnetic radiation to completely dissociate water into hydrogen and oxygen is, therefore, the key innovation discovered by Kanzius.

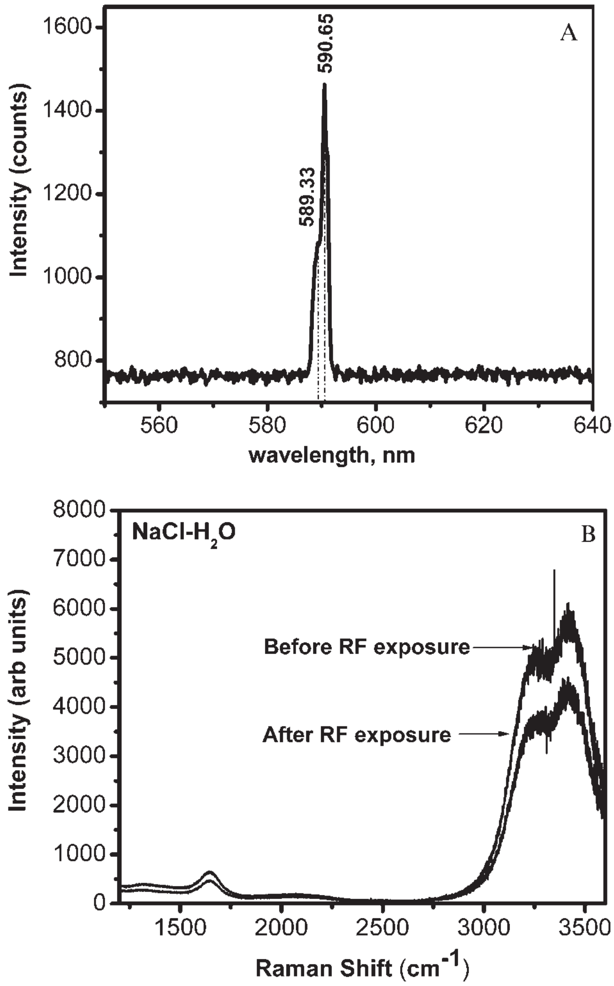
An interesting correlation exists with an example of a similar action of radiation on NaCl solutions in a recent paper by Brooks and co-workers.[17] They explain their phenomenon based on their detailed theory of 'spectral catalysis'. The most recent paper on work conducted at Penn State shows that when irradiated by Na–D line radiation, two important results are obtained

(i) a substantial change in the number and perfection of NaCl crystals grown from NaCl solutions
(ii) growth is achieved even from several percent under saturated solutions confirming the major effect of physical light photons on the thermodynamics of the system.

This shows that such electromagnetic radiation effects on condensed matter, range across at least six orders of magnitude of photon energy, covering visible light and short wave radio.

The work cited above on resonant RF effects clearly indicates the potential of specific resonant coupling of such radiation into the structure of aqueous solutions. What is new in the present work is the coupling of weak radiation with a liquid to dissociate simple aqueous solutions into continuous streams of intimately mixed hydrogen and oxygen. The gaseous effluents are obviously different from those obtained from electrolysis as they are produced mixed *in situ* simultaneously. Hence, the burning of these effluent gases should not be compared precisely with the burning of molecular hydrogen in air or the molecular oxyhydrogen mixtures.

Furthermore, it is important to find that the Raman spectral analysis of the saline solutions before and after the combustion confirms that there are substantial structural changes in the water structure. Figure 2B shows the Raman spectra of the saline solution before and after exposure to the Kanzius RF field. These are not discussed further in this context, but show that such changes in the structure of the liquid phase (*see* Ref. 8) are also correlated with such radiation effects, as also have been observed with microwave photons at 2·45 GHz (Ref. 10).



2 (A) emission spectrum from flame generated by exposing 3%NaCl solution to RF generator (characteristic Na–D line indicates that Na from small droplets ionises emitting D line) and (B) Raman spectra of saline solution before and after RF exposure

Conclusions

It has been confirmed that polarised RF frequency radiation at 13·56 MHz causes NaCl solutions in water, with concentrations from 1 to over 30%, to be measurably changed in structure, and to dissociate into hydrogen and oxygen near room temperature. The flame is a burning reaction, probably of an intimate mixture of hydrogen oxygen and the ambient air. Most of the Na present in the solution, concentrates progressively – as measured – as the water is dissociated and burned.

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