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Investigation of changes in properties of water under the action of a magnetic field

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The properties of water and their changes under the action of a magnetic field were gathered by the spectrum techniques of infrared, Raman, visible, ultraviolet and X-ray lights, which may give an insight into molecular and atomic structures of water. It was found that some properties of water were changed, and a lot of new and strange phenomena were discovered after magnetization. Magnetized water really has magnetism, which has been verified by a peak shift of X-ray diffraction of magnetized water + Fe_3O_4 hybrid relative to that of pure water + Fe_3O_4 hybrid, that is a saturation and memory effect. The properties of infrared and ultraviolet absorptions, Raman scattering and X-ray diffraction of magnetized water were greatly changed relative to those of pure water; their strengths of peaks were all increased, the frequencies of some peaks did also shift, and some new peaks, for example, at 5198, 8050 and 9340 cm^{-1}, occurred at 25℃ after water was magnetized. In the meanwhile, the magnetized effects of water are related to the magnetized time, the intensity of an externally applied magnetic field, and the temperature of water, but they are not a linear relationship. The study also shows a lot of new and unusual properties of magnetized water, for example, the six peaks in 3000—3800 cm^{-1} in infrared absorption, the exponential increase of ultraviolet absorption of wave with the decreasing wavelength of light of 200—300 nm, the frequency-shifts of peaks, a strange irreversible effect in the increasing and decreasing processes, as well as a stronger peak of absorption occurring at 50℃, 70℃ and 80℃, the existence of many models of motion from 85℃ to 95℃ in 8000—10000 cm^{-1}, and so on. These results show that the molecular structure of water is very complicated, which needs studying deeply. Furthermore, the macroscopic feature of mechanics, for instance, surface tension force of magnetized water, was also measured. Experiments discovered that the size in contact angles of magnetized water on the surface of hydrophobic materials decreases, thus the surface tension force of magnetized water decreases relative to that of pure water. It is seen from the above results that the clustering structure of hydrogen-bonded chains and polarization

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effects of water molecules are enhanced after magnetization These results are helpful in revealing the mechanism of magnetization of water.

pure water, magnetized water, magnetic-field, physical property, spectrum, saturation and memory effect, mechanical feature, surface tension force, polatization, angles of contact

Water is the most common and important material in nature. The growth and development of human beings, animals and plants need plenty of water, therefore both our lives and work, as well as agriculture and industry, cannot depart from water at all. Thus we may say that without water there is no life in the world. However, what is water on earth? What properties does water have? They are both challenging problems which need considering and studying completely and in detail. The changes in properties of water under the action of a magnetic field are also an interesting and important question, which has not been solved yet, although they have been studied for about one hundred years. The reason of generating these questions is that we cannot clearly know the features of the molecular structure of water and the influence rules of the magnetic field on its molecular structure. Many experiments show that water may be magnetized by a magnetic field[1−9], even though the magnetized effect is small. When water is exposed to a magnetic field, the so-called magnetization of water denotes its changes in properties including optics, electromagnetism, thermodynamics and mechanics, for example, the changes in the dielectric constant, viscosity, surface tension force, the solidifying and boiling point and electric conductivity, compared with those of pure water[1−9]. Thus, magnetized water has extensive applications in industry, agriculture and medicine, for instance, it may aid digestion and is helpful for eliminating dirt in industrial boilers, and so on[10−14]. However, the mechanism of magnetization and its features are not clear yet, although some theoretical models have been proposed, indicating that the magnetization of water is a very complicated problem, whose properties need investigating deeply by new theory, method and techniques. Therefore, to study the properties of magnetized water and its mechanism is of important significance in science and value in practical applications. Recently Pang[15−19] investigated the mechanism of magnetization of water and proposed a theory based on the molecular structure of water, some experimental data and nonlinear theory. In the model proposed by Pang the interaction of the externally applied magnetic field with the ring electric-current or "molecular electric-current" elements with the magnetism arising from the protons (or hydrogen ions) conductivity along the closed hydrogen-bonded chains of molecules occurring in water[15−23] results in the changes of distribution and features of water molecules, and thus the water is magnetized. In this theory the existence of the proton current along the hydrogen-bonded chains of ice given by Pang et al.[15 − 19] and some of its features, as well as the closed and linear hydrogen-bonded chains in water, are verified by many experimental results, for instance, the infrared spectrum of absorption, the solidifying and boiling point of water, polarization of water molecules, and so on[15−19,23]. In such a case it is very necessary to deeply and systematically investigate the properties of magnetized water and the natures of the molecule structure of water. This investigation may not only clarify the roots of magnetization of water but also explain the mechanism and features of biological effects of the magnetic field on human beings, animals and plants because there is plenty of water, about 70%—80%, in them[23,24]. In this work, we collect and study the light spectra of water and its features using some modern instruments and techniques, for

instance, the spectrum techniques of infrared, Raman, visible, ultraviolet and X-ray lights in Secs. 1 and 2. These spectra may embody the features of molecular, atomic and electronic structures of water, thus giving an insight into the structures of atoms and molecules in water and providing some accurate and credible data for the features of water. A lot of new properties are obtained.

1 The acting effects of magnetic field on water

We first measured the changes in optical features of water arising from the magnetic field. The magnetized water used in this experiment was extracted from a glass of 250 mL pure water at 25℃, which was exposed in a static magnetic-field of 4400 G (1 G = 10^{-4} T) for 20 min. Subsequently we respectively measured the spectra of visible and ultraviolet light for the magnetized and pure water in the range of 220—400 nm using a UV-2201 ultraviolet spectrometer made in Japan. The result is shown in Figure 1, where the result of pure water is denoted as curve 1. The so-called pure water consisted of only water molecules without other impurities, with a pH value of about 7—7.1, and its nature was assessed and checked using the instruments. Figure 1 shows that the absorption intensity of ultraviolet light for magnetized water is evidently larger than that of pure water, and increases exponentially with the decrease in the wavelength of ultraviolet light ranging from 150—260 nm. This means that the externally applied magnetic field greatly enhances the feature of ultraviolet absorption of water. The rule of exponential variation of ultraviolet absorption for magnetized water with its frequency was not observed, showing that water is magnetized by a magnetic field, before this. In the meanwhile, we also show the results of absorption of ultraviolet light for magnetized water at different magnetized times of 10, 40 and 60 min in Figure 1, where curves 1, 2, 3, 4 and 5 represent the intensities of ultraviolet absorption of pure and magnetized water with magnetizing time of 10, 20, 40 and 60 min, respectively. From this we see that the absorption intensity of ultraviolet light for magnetized water increases with the increasing magnetized time, i.e., the longer the magnetized time or the stronger the strength of the magnetic field, the larger the absorption intensity of magnetized water or the effect of magnetization of water. However, the rule that the absorption of water exponentially increases with the decreasing wavelength of ultraviolet light does not change at any magnetized time. Therefore, the result is an intrinsic nature of magnetized water, and its essence is worth studying deeply. This is due to the effects of clustering structure of molecules and polarization of atoms, as well as the enhancement of transition dipole-moment of electrons in molecules, according to the emission theory of ultraviolet light, when water is exposed in a magnetic field.

As known, the infrared spectrum of water provides an insight into its molecular structure. Thus we collected the spectrum of infrared absorption of magnetized water using a Nicolet Nexus 670-FT-IR spectrometer with the resolution of 4 cm^{-1}[18]. The results show that the intensities of absorption peaks of magnetized water are increased, but their positions or frequencies do not change in the range of 400—4000 cm^{-1}, when compared with those of pure water. This indicates that water is magnetized under this condition, but its molecular constitution does not change, and the polarized properties and transition dipole moments of molecules are only enhanced after magnetization relative to those of pure water.

We successively collected the absorption spectra of infrared light for magnetized and pure water in the range of 8000—10000 cm^{-1} using the ATR full-reflective technique with the Nicolet Nexus 670-FT-IR spectrometer, where the magnetized water was still extracted from a beaker of 250 mL

water at 25℃ exposed in the magnetic field of 4400 G for 25 min, shown in Figure 2. From this result we know that there is a new and strong peak of absorption at 9340 cm^{-1} in both magnetized and pure water, but the strength of infrared absorption of the former is larger than that of the latter, which has not been found till now. From Figures 1 and 2 we see that the magnetic field really changes the property of infrared absorption of water, thus we may say that water is magnetized in such a case.

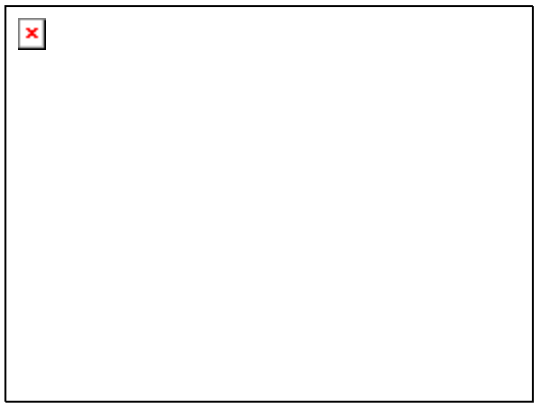

Figure 1 Absorption spectra of ultraviolet light for pure water (curve 1) and magnetized water of different magnetized time.

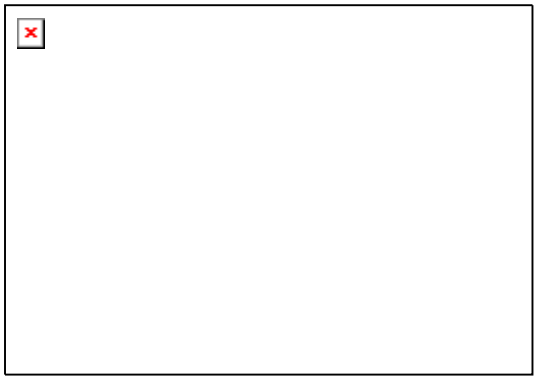

Figure 2 The absorption spectra of magnetized and pure water in the range of 8000—10000 cm^{-1}.

We also measured the Raman spectra of scattering of magnetized and pure water using JY-U1000 Raman spectrum instrument with a power of 400 mW and a source of an Ar^{+} ionic laser made in Japan. The magnetized water was extracted from a beaker of 200 mL pure water at 25℃ exposed in the magnetic field of 4000 G for 30 min. The experimental results in the range of 20—2000 cm^{-1} and 2000—9000 cm^{-1} are respectively shown in Figures 3 and 4. These figures exhibit that the frequency shift of some peaks and a new peak at 7900 cm^{-1} occur in the range of 7000—9000 cm^{-1}, and in 20—2000 cm^{-1} the strengths of all peaks are greatly increased, but the frequencies of these peaks do not change relative to those of pure water, for example, the relative absorption strengths of 1000 cm^{-1} peak for the magnetized and pure water are respectively 8400 and 2300, whose ratio is about 3.5 times. The result agrees with that of Jiang et al.[25] and Walrafen

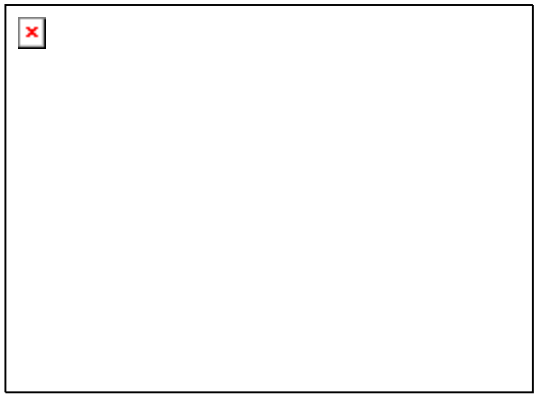

Figure 3 Raman spectra of magnetized water and pure water in the range of 20—1900 cm^{-1}.

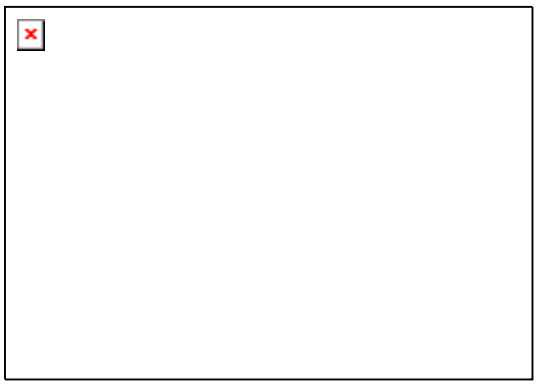

Figure 4 Raman spectra of magnetized water and pure water in the range of 2000—9000 cm^{-1}.

et al.[26]. This embodies that the externally applied magnetic field changes the properties of water. Thus we may say that the properties of magnetized water differ greatly from those of pure water.

We collected the diffraction spectrum of X-ray for magnetized and pure water at 25℃ by an XD-2 X-ray diffractometer with a Cu target made by Chinese Beijing General Co., which has a tube voltage of 40 kV, a tube electric-current of 30 mA and a scan step length of 0.02 degrees[18]. The magnetized water was taken from a beaker of 250 mL pure water at 25℃ exposed in the magnetic field of 4400 G for 40 min. The results indicate that the intensity of X-ray diffraction of magnetized water is larger than that of pure water, and the diffraction intensity of the highest peak in the magnetized water increases to 42872 cps from 39417 cps in the pure water. Thus the features of X-ray diffraction of water are changed under the action of a magnetic field. This shows that the atomic structure of molecules or polarization of atoms and enhancement of transition probability of electrons in the internal layers of atoms do vary after magnetization, when compared with those of pure water. At the same time, we measured the feature of interaction of magnetized water with magnetic matter in this way[18]. In the experiment we simultaneously added 2 mg magnetized nanoFe_3O_4 into 20 mL magnetized and pure water, respectively, and collected the diffraction spectra of X-ray from nanoFe_3O_4 plus magnetized water and nanoFe_3O_4 plus pure water in the above way. The results obtained show that the X-ray diffraction spectrum for nanometer Fe_3O_4 plus magnetized water undergoes a red-shift of about 2° relative to that of nanometer Fe_3O_4 plus pure water. This means that the magnetized water has certain magnetism, although this effect is weak because there is magnetic interaction and combination between the nanometer Fe_3O_4 and magnetized water, thus the red-shift may occur, the nanoFe_3O_4 cannot interact with pure water, and therefore, their X-ray diffraction spectrum does not vary. This is the first time to experimentally prove that magnetized water has magnetism. Its weaker magnetism is due to the smaller numbers of protons and water molecules responsible for this conductivity in the closed hydrogen bonded chains, which are only a portion of the protons and water molecules in water. This lends further support to the hypothesis that there are the closed hydrogen-bonded chains in water.

The above experiments are reproduced many times using water collected at different time and in different places, and the results are the same with the above data. From the above investigation we see that the magnetic field changes indeed the properties of water, and makes it magnetized. Thus its features of infrared absorption, Ramen scattering, ultraviolet absorption and X-ray diffraction generate considerable changes. These variations of spectra of magnetized water are caused by the changes of vibrations of molecules, displacements and excitations of atoms and transitions of electrons in atoms of water. Thus we may conclude that magnetic field changes the structures of molecules and atoms, as well as the motions of electrons in water. However, we find that the intensities of absorption peaks of magnetized water are only increased, their frequencies do not change in the infrared absorption and Raman scattering, thus we may confirm that molecular constitution of water generates no variations after magnetization. Then we may use the change sizes of intensity of infrared absorption to sign the effect of magnetization of water.

2 Some properties of magnetized water

2.1 The changes of magnetized effect of water with the increasing magnetized time and magnetic field strength, as well as the saturation effect of magnetized water.

In order to study the change rules we measured the changes in strength of infrared absorption of

water in the range of 400—4000 cm^{-1} with the increasing magnetization time using a 670-FT-IR spectrometer[18]. In the experiment the magnetized water used was taken from a beaker of 100 mL pure water at 25℃ exposed to a magnetic field of 4400 G for 10 and 20 min. The results obtained show that the strengths of the absorption peaks of magnetized water are greater with the increasing magnetizing time, namely the longer the magnetization time, the larger the strength of absorption. This means that the magnetized effect of water increases with the increasing magnetizing time, but the increasing rate of strength is not a constant and decreases little by little. When the magnetizing time is very long, during which the intensity of magnetic field acted on the water is sufficiently strong, the magnetized effect reaches a maximum, and then the properties of magnetized water no longer change, although the magnetizing time increases. Thus a maximum of peaks occurs in the infrared absorption spectra at this moment. This phenomenon is referred to as a saturation effect of magnetized water. In our experiment the effect occurs after 1 h magnetization. This phenomenon also occurs[18] in the larger wavenumber range of 4500—6000 cm^{-1}, in which we discovered a new peak of 5198 cm^{-1}, but the time of saturation magnetization of water is 80 min. The variations in intensity of infrared absorption of water exposed to a magnetic field of 4400 G for different durations and the corresponding saturation effect at 5198 cm^{-1} were shown in Figure 5 of ref. [18]. We see from this figure that the increasing rate of strength decreases gradually with the increasing magnetization time. The data in Figure 5 of ref. [18] were obtained using the ATR full reflective method with the Nicolet Nexus 670-FT-IR spectrometer.

In Figure 5 we also show the quantitative relations of strength change of infrared absorption with the increasing magnetization time at different magnetic fields of 600, 2000 and 3000 G at 5198 cm^{-1}, respectively. The data demonstrate that the strength of infrared absorption of magnetized water or the magnetized effect of water increases with the increasing strength of the magnetic field. At the same time, the saturation effect of magnetized water also occurs for different magnetic fields, but their times are different and shortened with the increasing magnetic field, about 110, 100 and 90 min for 600, 2000 and 3000 G, respectively. This saturation effect is also evident, suggesting that the amount of the magnetized element or "molecular electric current" with magnetism[15—19] is finite and does not change with the increase in the magnetic field, which is an intrinsic feature of water. This is an interesting result. It indicates clearly that there are indeed a lot of structure elements of molecules, which can be magnetized, in water. When an external magnetic field is applied on water, these structure elements become some small magnets or "molecular electric current" with magnetism, thus water is magnetized. This is just a main experimental foundation of the theory of water magnetization proposed by Pang[15—19]. Therefore, this effect is helpful for understanding the essence and mechanism of magnetization of water.

2.2 The memory effect of magnetized water.

From the above results we know that the magnetized effect of water increases with increasing strengths of the magnetic field or the magnetizing time. In general, the stronger the magnetic field, the larger the magnetized effect. However, once the externally applied magnetic field is removed from the magnetized water, we experimentally found that the magnetized effect does not disappear immediately, but maintains a very long time, and its intensity of infrared absorption decreases gradually with the increasing time and finally becomes the same with that of pure water after a certain time. This phenomenon is called the memory effect of magnetized water. We recorded the changes of infrared absorption spectra of saturated magnetized water at 25℃ with

the increasing time after the externally applied field is removed. For the magnetic field of 600 G we found that the magnetized effect is maintained for about 35 min before returning to baseline values or data of strengths of pure water. This means that the memory time of the magnetized water is 35 min. The result is shown in Figure 6. In this figure we show the corresponding results for the magnetic fields of 2000, 3000 and 4400 G, respectively. From the results we know that their memory times are different, which are respectively 45, 58 and 60 min. Therefore, the memory time of magnetized water increases with the increasing magnetic field. The "memory effect" indicates that there are magnetic interactions among the "molecular electric current" elements, which results in the magnetization of water. Thus, the time of magnetized water becoming pure water is postponed. Evidently, different magnetized waters generated by different magnetic fields have different memory times due to the different intensities of interaction among these "molecular electric current" elements[15−19].

In practice, all magnetized water has a saturation and memory effect, the distinctions are only the differences in the saturation and memory time, and the time depends on not only the amount and temperature of magnetized water but also the strength of the magnetic field and the magnetizing time. Therefore, the saturation and memory effects not only are an elementary nature of magnetized water but also further support the mechanism and theory of water magnetization proposed by Pang[15−19].

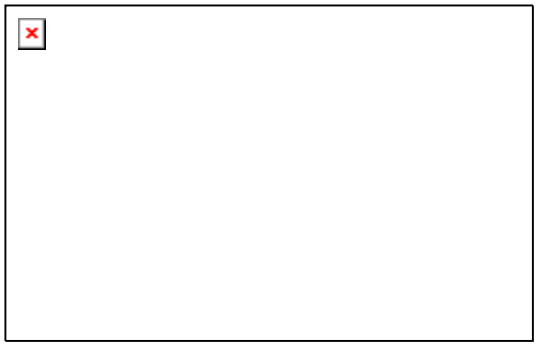

Figure 5 The strength change of infrared absorption with the magnetized time at different magnetic fields.

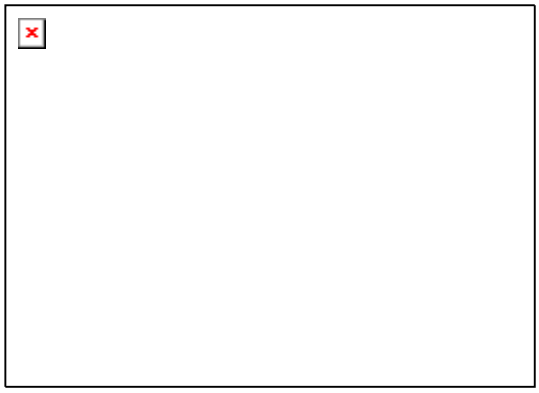

Figure 6 The change in strength of infrared absorption of magnetized water after the magnetic field is removed.

2.3 The influence of water temperature on the magnetized effect.

In general, the magnetized effect of water depends on its temperature and decreases with the increasing temperature. We measured the changes of infrared absorption of magnetized water with the increasing temperature from 35℃ to 95℃ in the range of 400－4000 cm^{-1} using a 670-FT-IR spectrometer, and the magnetized water was taken from a beaker of 300 mL pure water at 25℃ exposed to a magnetic field of 4400 G for 40 min[16]. The result shows that the strengths of infrared absorption of magnetized water decrease, but the frequencies and frequency shifts of these peaks increase in the range of both 3000－3800 cm^{-1} and 1500－1600 cm^{-1}. We roughly estimated that the absorption strength of the peak decreases about 5%－8% and the frequency of the peak shifts about 2－4 cm^{-1}, when the temperature of water increases 10℃ each time. This is due to the increase in thermal energy of disorder motion of molecules with temperature increasing, which

results in the increase of nonlinear vibration of molecules and the decrease of numbers of molecules in the clustering structure of hydrogen-bonded chains, as well as the changes of distribution of molecules in water.

We investigated the changes of infrared absorption of magnetized water, which was extracted from 300 mL water exposed to the magnetic field of 4400 G for about 60 min, in the near-infrared region of 8000－10000 cm^{-1} with the increasing water temperature from 25℃ to 70℃ using a 670-FT-IR spectrometer and the transmission method of liquid bath. The result is shown in Figure 7(a). From this figure we see that not only the strengths of the absorbed peaks increase and the frequencies of peaks undergo a red-shift with the increasing water temperature, but also a maximum peak of absorption of 9340 cm^{-1} occurs at 50℃. When the temperature is continuously increased, the intensity of this peak decreases gradually, and its frequencies are shifted toward the direction of decrease with the increasing temperature. However, when the water temperature decreases from 70℃ to 25℃, its absorption characteristics of infrared light are not the same with the above result, which is shown in Figure 7(b). In this case, the intensity of absorption increases with the decreasing temperature, and the peak of 9340 cm^{-1} at 50℃ is shifted to 9420 cm^{-1}. The variation in the wavenumbers of absorbed peaks with temperature in the processes of increasing and decreasing temperature for the 9340 cm^{-1} peak is shown in Figure 8. The resulting curve is anomalous. Hence, they are not reversible each other. Further anomalous phenomena for the 9340 cm^{-1} peak occur in the range of 75℃－90℃; not only the frequency-shifts of the peaks occur during the processes of increasing and decreasing temperature, but many extra absorption peaks of 9150, 9350, 9440, 9450 and 9500 cm^{-1} are also generated in the process of increasing temperature, and the peak of 9500 cm^{-1} at 85℃ annihilates again in the process of decreasing temperature. The numbers of such peaks at different temperatures are also different, as shown in Figure 9. The above experiments were reproduced many times using water collected at different time and in different places, but the results are the same. This is a typical irreversible process or hysteresis effect. These experiments have not been done up to now. These unusual features of magnetized water occurring in the near-infrared region in Figures 7－9 are difficult to explain using the existing physical theory. This shows that the molecular structure of water is very complex, in which there are a lot of clustering structures of hydrogen bonded chains of molecules. The interactions and relaxations among these clustering structures of molecular chains result in the occurrence of the above phenomena. In

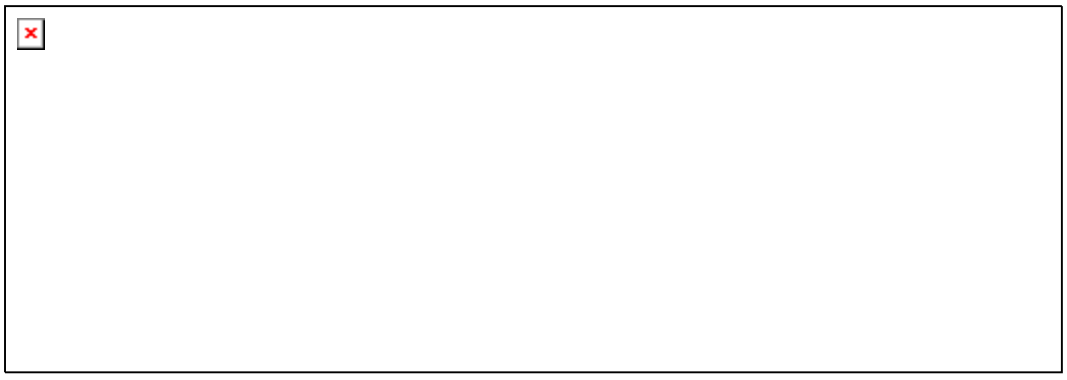

Figure 7 The spectra of infrared absorption of magnetized water in 8000－10000 cm^{-1} in the increasing (a) and decreasing (b)

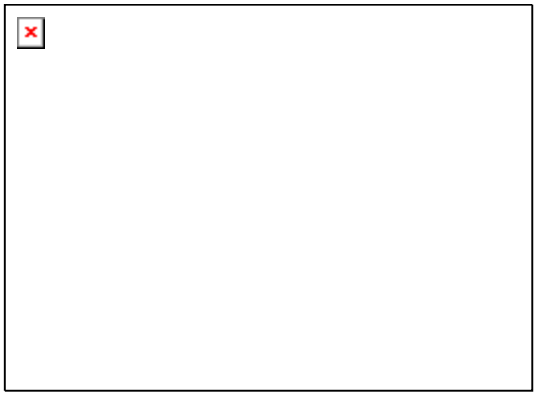

Figure 8 The changes in wavenumbers of the infrared absorption peak at 9340 cm^{-1} for magnetized water in the increasing (a) and decreasing (b) processes with water temperature, respectively.

processes from 25℃ to 70℃, respectively.

such a case we have to consider that water or magnetized water could not be a Newtonian fluid, but non-Newtonian in nature. Thanks to the infrared absorption with the wavelength of about 1 μm arising from the transition of bonded electrons with high energy in water molecules, the mechanisms underlying these phenomena at high temperature are due to the combined effect of the hydrogen-bonded structure of molecules, the action of externally applied magnetic fields and the thermal effect of high temperature on the viscosity of water. In this process the combined effects of the thermal energy absorbed by water and energy of magnetic field convert into higher transition energy of electrons, which results in different infrared transitions with high energy for the bonded electrons in the molecular chains and the occurrence of many peaks of infrared absorption at high temperature. The interactions and relaxations of the combined effect and its relationship with water temperature result in different interaction and distribution of molecules in the increasing and decreasing processes, and thus the irreversible phenomenon occurs in such a case. Certainly, the mechanisms underlying these phenomena require further extensive study.

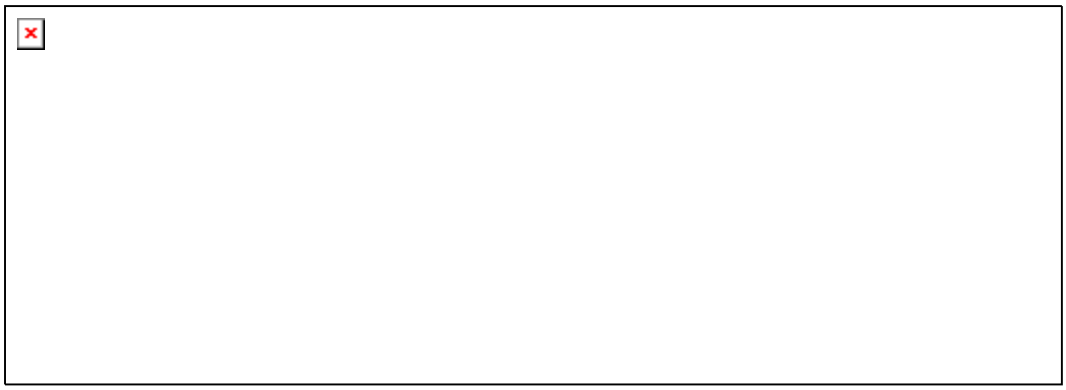

Figure 9 The spectra of infrared absorption of magnetized water in 8000－10000 cm^{-1} in the increasing (a) and decreasing (b) processes from 75℃ to 90℃, respectively.

2.4 The changes of surface tension force of magnetized water

From the above investigation we know that the magnetic field results in variations of distribution and clustering structure of molecules, which cause necessary changes of macroscopic properties of water including the surface tension force and soaking degree. We here investigated the variation of surface tension force and soaking degree of water to materials through measuring the size of contact angles of magnetized and pure water on the surface of the materials including copper, graphite and muscovite in the range of 0°－180° under the condition of humidity of 27° using OCA40 Micro optical-vision instrument with the accuracy of ±0.3° made by Germany, respectively, where the magnetized water was taken from a beaker of 250 mL pure water at 25℃,

which was exposed in the magnetic field of 4400 G for 30 min. In this measurement, 3 μL water injected was used, with the injecting speed of about 0.5 μL/s. As known, muscovite is hydrophilic, but copper and graphite have different hydrophobicities. We measured the sizes of contact angles of magnetized and pure water at five different positions on the surface of the materials, respectively, and finally gave the average value of five different values for the contact angle of magnetized and pure water, respectively. The experimental results of copper, graphite and muscovite are shown in Figures 10—12, respectively. From these figures we see that the contact angles of magnetized and pure water on muscovite are almost zero, and the difference between them is extremely small. Therefore, the soaking degrees of pure and magnetized water to muscovite are both very large. However, for copper, the contact angles of magnetized and pure water are about 146.8° and 147.2°, respectively; while for graphite, they are about 91.2° and 92.6°, respectively. Thus, the contact angles of magnetized water are decreased relative to those of pure water, and the differences are respectively about 0.4° and 1.4° for copper and graphite. Although these differences are small, we may affirm that they arise from the externally applied magnetic field because these values surpass the error range of the instrument by 0.2°. The extenuation of contact angles of magnetized water means that its soaking degree to the hydrophobic materials increases and its surface tension force does decrease relative to that of pure water, and thus its hydrophobicity decreases. This shows that the magnetic field may change the hydrophobicity of water. The extenuation of contact angles of magnetized water is due to the increase of polarized effect and the changes of distribution and clustering structure of water molecules after magnetization.

Figure 10 The contact angels of magnetized water (a) and pure water (b) on the surface of copper.

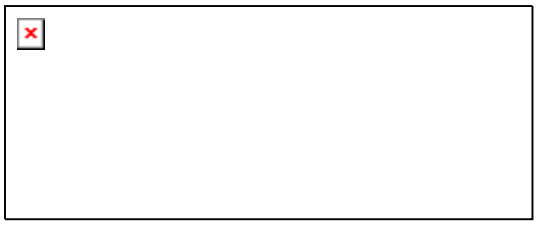

Figure 11 The contact angels of magnetized water (a) and pure water (b) on the surface of graphite.

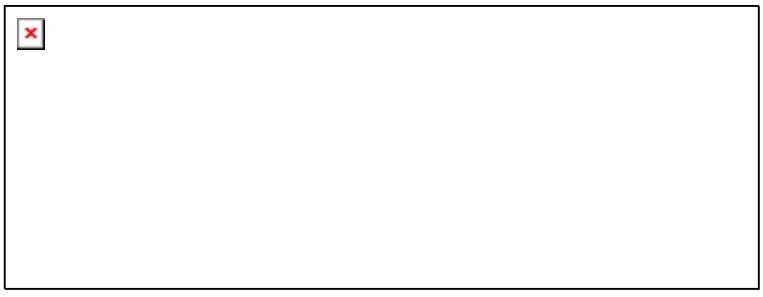

Figure 12 The contact angels of magnetized water (a) and pure water (b) on the surface of muscovite

3 Conclusions

We measured and gathered the spectra of infrared, Raman, visible, ultraviolet and X-ray lights of magnetized and pure water. These spectra represent their features and states of atomic and

molecules structures. The repeatability of these experiments is very high, the instruments used are updated, and therefore the experimental results are reliable. From these spectra and the measured result of surface tension force we not only know the considerable difference of optical and mechanical features of magnetized water with that of pure water but also have an insight into their variations of atomic and molecular structures induced by the magnetic field. In other words, we see experimentally that the externally applied magnetic field may result in considerable changes of water, and makes water magnetized. These changes in features of magnetized water relative to those of pure water may be summarized as follows. The strengths of infrared absorption increase with the increasing magnetic field, the magnetizing time and the decreasing water temperature in the range of 400—4000 cm^{-1}, the strengths of peaks of Raman scattering increase greatly and the frequency-shifts of peaks occur in 20—2000 cm^{-1}, but they are not a linear relationship; new peaks of infrared absorption occur at 5198 cm^{-1} in 4300—6000 cm^{-1}, at 9467 cm^{-1} in 9100—10000 cm^{-1} at 25℃, and at 9150, 9350, 9440, 9450 and 9500 cm^{-1} in the ranges of 50℃—90℃ and 8000—10000 cm^{-1}, as well as at 7900 cm^{-1} in the range of 7000—9000 cm^{-1} in the Raman scattering spectra; the intensity of ultraviolet absorption increases; X-ray diffraction spectrum greatly changes, etc. In the meanwhile, we found that magnetized water has an evident saturation, memory effect and magnetism through the experimental comparison of X-ray diffraction of nanoFe_3O_4 plus magnetized water from that of nanoFe_3O_4 plus pure water. Some new and unusual phenomena of water were also discovered, for example, the strange irreversible effect of infrared absorption in the increasing and decreasing processes of temperature at high temperature, the exponential increase of ultraviolet absorption in the range of 200—300 nm and the existence of six peaks of 3037, 3165, 3280, 3415, 3540 and 3665 cm^{-1} in the range of 3000—4000 cm^{-1}[1[1—19]], which are not altered by changing water temperature and the externally applied fields, thus are an intrinsic feature of water. The above properties of magnetized and pure water are helpful for revealing the structural features of water molecules and verifying the correctness of the mechanism and theory of magnetization of water proposed by Pang[15—19]. In fact, from the physical significances of the above six peaks and their identification of molecular vibrational modes Pang[15—19] affirmed the existence of clustering structure of linear and ring hydrogen bonded chains of molecules in water. He thought that the peaks of 3540 cm^{-1} and 3665 cm^{-1} should attribute to the symmetric and antisymmetric stretching-vibrations of OH bonds without hydrogen bonds in free water, the 3280 cm^{-1} and 3415 cm^{-1} should attribute to the symmetric and antisymmetric stretching-vibrations of OH bonds with hydrogen bonds in linear hydrogen-bonded chains and are a result of the red-shift of frequency of the former, respectively, due to the occurrence of linear chains, the 3017 cm^{-1} and 3165 cm^{-1} should attribute to the symmetric and antisymmetric stretching-vibrations of OH bonds in the closed hydrogen-bonded chains and are a result of the red-shift of frequency of 3282 cm^{-1} and 3416 cm^{-1}, respectively, due to the forms of closed chains[15,16,19]. Based on the molecular structure of water Pang further established the theory of magnetization of water according to the theories of proton conductivity in the hydrogen bonded systems of ice[17—22] and magnetism of matter. If water is exposed in a magnetic field, these closed hydrogen-bonded chains become some ring electric-current or "molecular electric-current" elements with magnetism due to the proton conductivity in them under the action of Lorentz force of the magnetic field[19—24,25], the magnetic interactions of these "molecular electric-current" elements with each other or with the externally applied magnetic-field result in the changes of distribution and features of water molecules and the

magnetization of water. The above experimental results, for example, the occurrences of six peaks in different ranges of temperatures and magnetic fields, saturation effect, memory effect, the irreversible process in the changing process of water temperature, the exponential increase of ultraviolet absorption and magnetism effect of magnetized water, support and convince the real existence of clustering structure of hydrogen-bonded chains of molecules and magnetic interactions among these clustering structures of molecules in them. Thus these experimental results verify that Pang's theory of magnetization of water is correct and credible.

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