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Research Article

Radio frequency He4 and sonoluminescence photons are combined

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Abstract

Two systems are presented in this paper: 1) describes the Radio Frequency, RF, reactor that produces alphas and 2) the polycarbonate reactor that produced sonoluminescence, SL or gammas several years earlier. During experiments, dV/dt rapid changes were noted in volumes of proton and deuteron capturing an electron as the initial temperature cools. This is a very basic event at the atomic level. The $D^{+} + e^{-} D^{*}$ will produce a shockwave that is only compressive for the elemental hydrogen isotopes. The shock wave that destroys the MC cluster of deuterons in a squeezing process, ends with an explosion that excites the MC debris. An excited state occurs where a free MC deuteron combines with the D*forming an alpha as part of the debris system for that cycle. He4 was collected in the Ar gas phase for a mass spectroscopy analysis, MS. Only the 3 hydrogen isotopes have the potential of the large dV/dt compression.

Old measurements of the sonoluminescence (SL) photons emitted during DOD cavitation fits RF experiments, and it was never thought He4 might be associated with SL. But a closer look makes a case that SL and gamma photons were the same. The RF system during DOD cavitation could be associated with the improbable equation 2D He4 + g. The measured SL fits the RF He4 MS measurements. The advantage of the RF amplifier driven system was its freedom of a locked frequency of the oscillator driven systems and can be frequency tuned while running. The system could be tuned off for 5 s temperature measurement in the 30 s run mode, thus avoiding the high RF field interference to thermocouple measurements. This SW system was impressed with Lawandy's like charge attractive forces system that was compatible with MC SW system making the experiments that yield other He4 paths. These were single events of a few atoms, with high activity electrons for a short time, during a 2-MHz cycle.

Keywords: Radio frequency, cavitation, image forces, electrons, deuterons, femtoseconds, target foils, He4 MS, and sonoluminescence

1. Introduction

The production of He over the years of cavitation efforts was always observed. It was a less controversial signature of a nuclear event than heat is. The cavitation process occurs primarily in DOD with an attempt to keep temperatures low throw circulation into heat sinks. In the beginning at a frequency of 20kHz and a 16 L water cooling system, results showed tremendous damage to the metal target foils, TF 50 × 50 × 0.1mm, as shown in SEM photos [1]. These were followed by increases in frequency to 46 kHz, 0.625 MHz, 1.6MHz, and 2 MHz as shown in Fig. 1.

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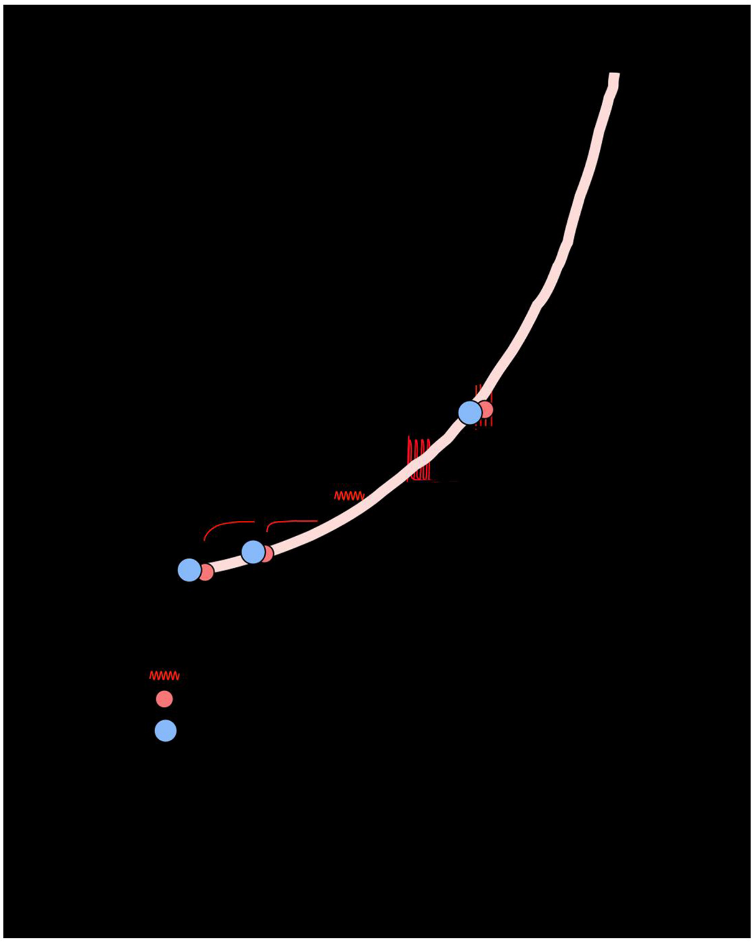

Figure 1. A collection of cavitation experiments that are quite varied seem to fit a predictable sequence going from low frequency to high. I have not found support for this but the numbers look promising. Another paper described the missing link between high and low frequency at about 100 kHz [2]. This paper suggests that one is entering a new energy response as one progresses into the higher frequencies.

The activity of the adiabatic bubble collapse distribution changes from what appears to be a continuous distribution through the cycle to a zone of less to no activity at the end of the cycle. There was not enough pulse energy to carry the higher frequency to the end of its period or wavelength. As the frequency increases, there was a smoothly increasing transformation to no bubble activity. In Fig. 1, it appears that above 100kHz one might expect to see this process to be noticeable [3].

The high dr/dt powers the unique shockwave that influences the production of He4. It has the potential (rD*-rD$^+$)/(1.6E-15)m/s which gives a potential velocity approaching the speed of light. The RF cavitation system gives more freedom for gathering information about the effects frequency and energy in Sonochemistry, as well as the enhancement of paths using images of like charge attractive forces of N. Lawandy [4].

2. A probable path to He4

2.1. What is the RF shock wave, SW, system.

The RF cavitation system uses a target foil 18 $\times$ 5 $\times$ 0.1mm with 2 surfaces that are active. The activities that are examined are at the atom level and over a period of 50 fs, so the electrons are the particles with movement. Looking at a few atoms in a target foil just implanted with electrons then deuterons, the process heats a few lattice atoms to gas phase temperatures $\sim$5000K where a short-lived charge separated MC of small size with its few deuterons was anchored to one of several surface points between TF atoms, which are basically static due to the fs time frame. The driving force to neutralization was in the initial charge separation, guided by the jet higher velocity plasma electrons [5]. The focused movement of electrons to MC squeezed its deuterons and the heat sink of TF atoms removed heat via Cu cooling coils. The MC deuterons in a cooling environment were able to capture an electron in the fs timeframe, thus becoming the D* atom. This event destroyed the MC with its SW and from the debris the $D^+ + e^-$ à D* combined an MC debris deuteron to form an He4 + g. The g was the SL and supplies the energy balance D*-D^+ He4 + g [5]. This powerful SW creates an explosion, expanding D^+ to D* in a time period of 6E-15 seconds with a tremendous impulse. This same methodology can be transferred to the proton system in the same time frame.

2.2. A series of three figures illustrating the path to alpha

Figure 2 shows 2-MHz input as it produces in one cycle a small bubble, Ri, that starts a rapid expansion in the low pressure in cavitating DOD, Ro, and continues picking more mass reaching and in an adiabatic collapse of the partial vacuum that ends in a burst of photons, SL, and plasma of dissociated DOD. The SL radiation was measured, Fig. 6a and b, and can account for the energy balance in 2E He4 + g. The jet plasma first implant electrons into the TF lattice surface producing many hot spots around 10K for the following deuterons that form small clusters of 2 to100 ions, MCs.

Figure 2 shows the RF cavitation at 2 MHz where adiabatic collapse of a growing bubble from Ri to Ro accumulates DOD mass though its expanding bubble interface reaches Ro, the bubble was still a partial vacuum, at the red line reaches an instability and implodes into plasma jet and SL at Rf. In the upper left, the SL pulse was short as measured in Fig. 5a and b, see Fig. 3. In the lower right shows complete activity in the yellow spheres of the TF where the jet plasma was implanted into the TF lattice forming MC s of D^+ clusters. First, the fast and small electrons and deuterons exist together. The temperatures were too high for any combination forming D*. Some electrons were stripped the lattice adding to mobile electron fields and focused on the deuterons, in the MC, blue spheres, as the system cools.

This surface activity strips more electrons from TF, light blue fields, adding more free electrons to a 50 fs charged system. The MCs are very small and are lost interstitially in space between TF surface atoms. These MCs are shown as two blue dots, shown much bigger in scale, and too hot for recombination with electrons.

2.3. Sonoluminescence, SL, related to He production, photon emission

The number of photons measured by the MPPC indicates the clumping of SL photons caused by the adiabatic bubble collapse. An event for a 0.625 MHz that was over in less 0.11. The pulsing SL photons indicated their energetic events were produce by collapsing cavitation bubbles. The activity in the bubble that was located in the MPPC measured photons also includes the He4 production. The pressure increase can no longer resist a momentum movement in the opposite direction initiating the adiabatic collapse in the partial vacuum of the bubble. The energy and deuterons produced was in plasma jet where some will reach the TF, yellow sphere. Transferring electrons to the lattice surface it will add deuterons that will form clusters, MC small blue circles too hot for a deuteron to capture an electron. The electric fields, EF light blue, were in motion in the lattice in the 2500K cooling environment.

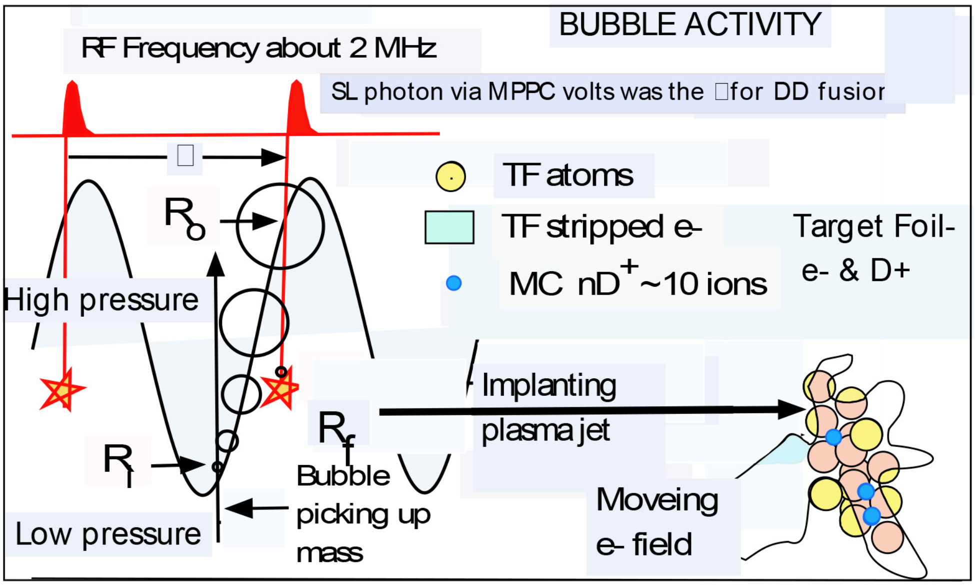

Figure 2. The short period of bubble activity and the implanting of the TF deuteron filled MC and the only movement of electrons in the 50 fs timeframe drive to neutrality and He4.

2.4. Shockwave, SW, destruction of the MC during He4 production

The rapid dV/dt SW produced by an electron capture by MC deuteron that was cooling to 2500K and the probability that one of the MC's deuterons will capture and electron during the 50 fs timeframe increased in size E+10^9 times in 6E+15 s exploding debris that contained alphas. In the debris was an alpha, He4 atom. If the TF was a BCC lattice it would be in the gas phase over Ar saturated water [6]. The low solubility of Ar and He4 along with cavitation pushed most of the product onto the gas phase. The number of Ar atoms in the gas phase was determined by Malcom Fower of AIM lab, along with a sophisticated MS analyses to determine the number of He4 atoms produced in a particular experiment.

2.5. The MPPC measured photon SL emission, the photon reactor

Figure 5a–c that was SL data gathered several years earlier has been connected to RF experiments to account for the missing energy of 2D He4 + g. The high energy g can be related to down-graded photons measured in Fig. 5a. These g could not be measured during RF experiments as they need absolute darkness to be measured. The photon as SL and measured by MPPC are couple to input cavitation frequency as shown in Figs. 3 and 4. It shows a 0.625-MHz frequency in a DOD cavitating system that was 1/3 the RF frequency, but that should not make much difference. When looking for sonoluminescence (Fig. 5b), SL used a cylindrical PZT piezo driver by a frequency generator in a D_2O cavitation system in photon black felt multiply lined dark box, a l6-inch cube of dark space. The SL source, which as $\sim$12 mm, was used as a point source, and placed 4, 8, and 16 inches from the MPPC photon volt output for many measurements. The changes in geometry followed the optical laws where intensity changes as 1/the square of the distance. The data was shown as pulses coupled to the frequency with an activity time of about 6% of the period. Which in this case was 1600 nm. In Fig. 6c, the circulating D_2O kept the temperature a few degrees above ambient

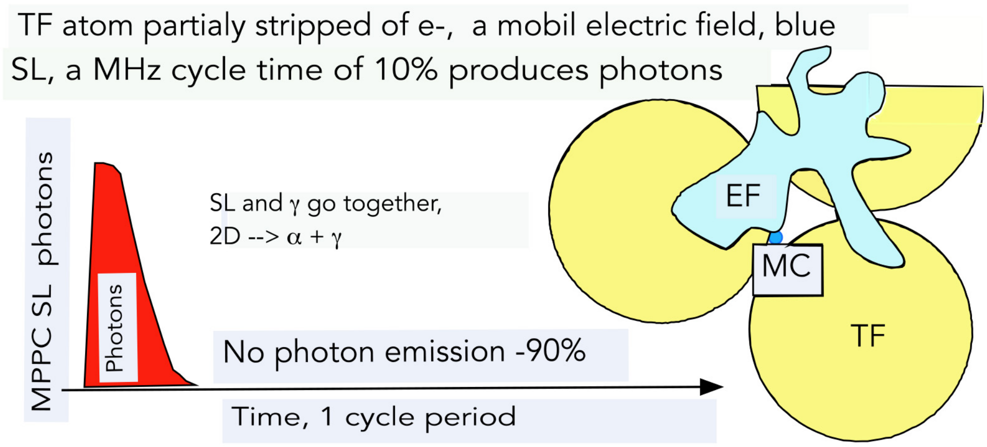

Figure 3. Other related TF activity during the time of the SL pulse in red and is the sum of all SL photons during the 1 SL pulse or cycle. Everything that happens in the TF where the timeline 50 fs of accumulation event during one cycle produces ∼ E+9 photons per event with many events measured in Fig. 5a. The MPPC sensitivity range 300 to 900 nm so it was unknown what was missed. The SL pulse about a fraction of a cycle period of degraded gamma photons reaching the MCCP sensors. In the cutoff UV photons were not counted. During the time SL was produced the lattice activity includes the mobile electric fields, EF, and the production of MC, blue dots. This environment is a good fit to fusion mechanism that N. Lawandy's paper described as the image forces between like charges and were enough to fuse D atoms. See Fig. 8.Figures 6a and b show more information about the RF reactor.

(24°C). Typical data is shown in Fig. 6a, the l in nm versus the voltage output from the MPPC, that was related to the number of photons emitted to from that peak during a time period. This SL and the source of these photons was speculated to be related to the production of He atoms, where the energy of the gamma was carried off with the degraded SL photons. See equation for alpha production, 2D a + ga very unlikely fusion equation. The energy of the gamma was disbursed as SL photons related to Fig. 2, 2, and 6b as there was a burst of photons 6c, related to PTB at a frequency output coupled to the piezo power input [3].

The most important finding was He4 measurement by mass spectrum analyses on several occasions from cavitating water systems both HOH and DOD, and their fit with SL measurements in 2010. The largest power output was 6 watts for 250 s from an RF system with a Pd/6%Ag TF with an active volume of $5 \times (18^{-10}) \times 0.1\text{mm}^3$ in DOD producing 4.25E+14 He4 atoms. This is what you get when put 30 years of cavitation experiments together. There was a 6-year separation between SL and SW experiments. SL has been a physics mystery and explanations for their presence as perhaps hot spots fits [7]. The evidence now shows that SL photons that were a stand-alone phenomenon now are associated with producing helium and its g but the He were in amounts too small for general MS measurements.

2.6. Pd wire experiment, measuring SL photons

Figure 5a and b is a more detailed look at SL. The equation D + T He4 + n + g was similar to 2D He4 + g [5] ordinarily and has no neutrons and has a low probability except it does fit the data with a little stretch. This shows a collection of photons numbering ∼E+9, all initiated from the wire during the active part of the cavitation cycle. See the red pulse in Figs. 2 and 3. The SL photons emission measurement via MPPC occupy less than ∼6% of the period of the input cavitation cycle. The photon occurs in a very fast event, E-11 s, and are of a mystery source at this point [7]. There

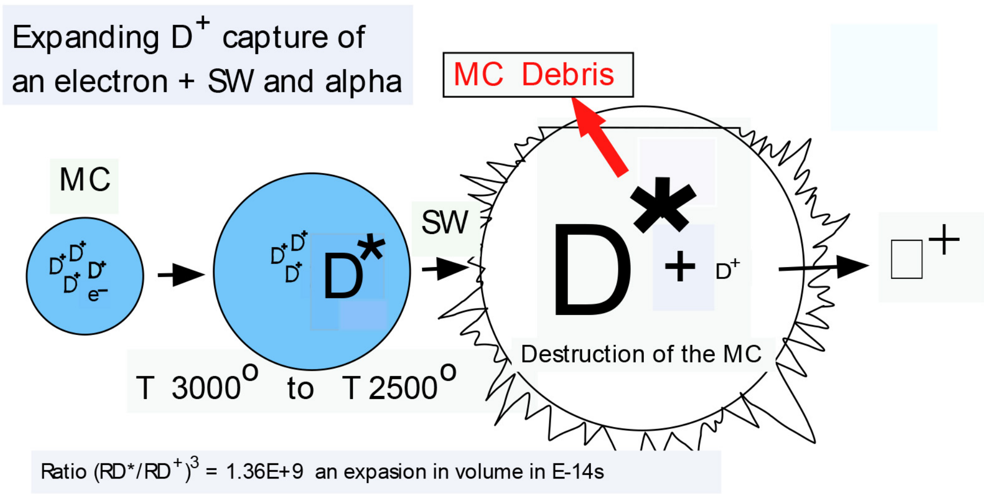

Figure 4. Figure 4 shows the MC with a few ions and an electron. The charge attraction is strong, but it is too hot, and the system must cool in its 50 fs widow. The first deuteron capture of an electron initiates the rapid volume growth, $D^+ + e^-$ to D* that destroys the MC and where D* combines with a debris D^+ producing an a^+ ion. The ratio of radius cubed volumes goes from 1 to 10^9 in 10^{14} seconds and produces the SW. Breaking system down to a few particles shows paths to unique events. All parameters should be viewed loosely for best fits.

may be as many as E+9 photons average in each burst, see Figs. 3 and 5a. This would be a solid resolution to the SL mystery as the missing energy.

In 2011, a series of experiments were finished using the cylindrical PZT piezo with a 40 gauge and 35 mm in length of Pd wire (only 12 mm were active) from MWS wire industries. The wire was exposed to DOD cavitation in the dark and at some distance MPPC 100 was in-place to measure photons in the range of 300–900 nm wavelength. The purpose was to produce sonoluminescence, SL, photons. About 10 + experiments and the data measurements were printed. I would like to do a simple experiment, a comparative analysis of that exposed wire and compare it to the next segment an unexposed wire. Look for element surface changes, He4 and isotope changes. Pd is an FCC lattice so I would not expect to find He4 except as TF lattice background He4 .

3. Differences between structures of target foils

When TFs were exposed cavitation inputs, their lattice structure respond differently depending on their crystal types.

3.1. The cavitating AF system in the MC in BCC and FCC, and their debris

The MC operates as a spherically squeezed piston. The AF that takes place in the MC before it terminates in a 50 fs timeframe. During this time the configuration was shown in Fig. 8, where AF was a possible producer of alphas. The debris from MC reverts back to the starting material and steady state of D_2, O_2, DOOD, and D_2O was present only in the FCC system. The BCC TF lattices from limited studies indicate all a remain in their associated TF lattice [6]. A parallel mechanism for the HOH RF system also exists. The debris was pushed out from the center of cavitation, self-cleaning [11].

Only those TF that produce craters will show MS measurements producing that migrates to the Ar gas phase. On the other hand, the Ti and also Zr, Hf, Va —TFs that normally do not produce craters—were BCC lattice structures

Figure 5a was 1/3 the f of 2MHz

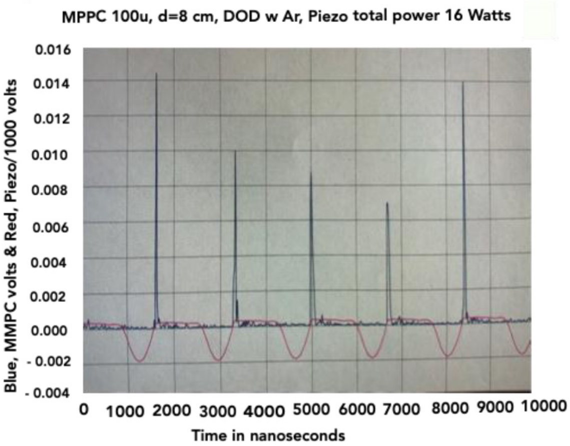

Figure 5b Figure 5c

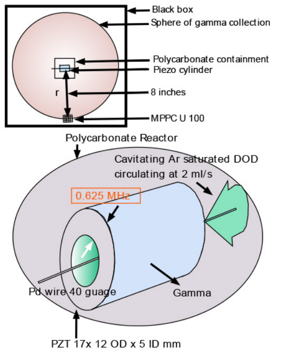

Figure 5. Figure 5a. 1 of 20 experiments showing the output from MPPC (SiPM) 100U, Hamamatsu generously donated, in a geometry of MPPC spot on the surface of an 8-inch radius sphere, and a small 50 mm Pd wire polycarbonate reactor shown in Fig. 5b. The circulation of DOD pressurized with Ar and driven with a cavitation input power of 16 Watts. The data collected by MPPC output of 140 millivolts average in Blue, and the piezo input was 16 Watts in red. The period in nano seconds was 1600 and the frequency was 0.625 MHz. The highly resolved SL data looks like a gamma spectra and SL photons that were downgraded gammas. Figure5b shows a polycarbonate reactor for measuring the gammas emitted through the PZT piezo cylinder, 17 mm, 12mm OD, and 5 mm ID. This was about a 7mm thickness of PZT plus 10 mm of polycarbonate for the gammas to pass through. The gammas were degraded to the SL photons that are shown as highly resolved peaks coupled to the piezo frequency, 0.625 MHz, in Fig. 5a. From Fig. 2 and 3 the activity was no more than 6% and after, the time rest mode. In figure 6c the green arrow indicates the DOD that was circulated through the piezo at was in contact with the Pd wire, at ∼0.55ml/sec, for 0.84 seconds. Volume of DOD in the piezo was 0.462 cm^3 and a flow rate of 2ml/s. The cavitation temperature was kept constant at about ambient. The polycarbonate containment dark box easily handled the 16-inch radius system.

and the alpha product remains within the TF lattice [6] either on the surface or deeper for the Ti BCC TF. The Ti TF also produce 1μ TiOx tubes shown in SEM TF surface photos [9]. The electrons are where the activity was, and the two systems, AF and SW, may work together focused on the MC to produce electromagnetic fields squeezing the of MC contents tangent to the MC spherical surface as the electrons move to the center of the positive charge. The distance between deuterons was managed by a spherical squeezing geometry. And this happens when applying the Lawandy's AF to the MC system. There can be several of these like charge attractive force systems working at the same time. One can see that both the SW (shockwave) propagation and the attractive force of like charge particles can work together in the production of alphas. This information comes primarily from the Ti3-A experiment that measured He4 locked in the TF lattice by the MS of gas evolution from the melted Ti TF [6]. And contrasts them to two experiments that used Pd foils where was He4 would be found in the crater ejecta, unfortunately there was no MS Ar gas measurements made.

3.2. TFs and the ejection crater and the information they hold

An FCC TF and the cavitation produced crater was a single event that was grouped with the smallest craters produced in great numbers. These 50-nm craters were often found in bunches. SEM photos showed evidence of smaller craters but appeared to be few in number that maybe the result of older damaged craters from a continuous crater modification that was produced by cavitation. These are found in SEM photos [1]. In some systems at low frequency inputs, 20 kHz, it was possible to look through a quartz window and follow the glinting TF surface modify at rate one could visually see that a hole was growing in the foil over a 5-min period. There is video of that somewhere. When cavitating the surface of TFs, they were in a state of constant change with every cycle. At high frequencies like 2000 kHz, small 50 nm in radius craters evolving at a steady rate of formation and destruction during the cavitation process on the surface FCC TFs. New craters were continually replacing the old. SEM photos reveal the last generation cycle of crater production. The TF surface was continuing to evolve until the power was turned off. The SEM of removed TF lattice shows the latest version of the crater surface that was frozen in the lattice and can be studied at a later date when the instrumentation is available. There is a hundred of these exposed foils in storage. The SEM photo would only show the last 50 fs of the 0.625-MHz cycle of the cavitation continual modification of the TF lattice surface.

3.3. Depending on the crystal structure the paths differ

If there was crater formation during an RF experiment, then the path was a generated SW from within the MC where an electron was captured by D^+producing the SW that destroyed the MC and created the ejecta, debris, and the ejecta crater of one alpha production with an FCC lattice path, and 1.6E-12 J. If there were no craters formed and the alphas were in the lattice, and the path was BCC path. Only the TF lattice structure plays an important part as the information throughout this paper basically covers FCC TF lattices, where cavitating Ar saturated water produce craters that were shown in SEM photos. The He4 measured by the MS was ejected into the gas phase for the TFs, Fe, Pd, Ag, Ni, Pd, Cu, ... Other crystal types like the BCC Ti, Va, Zr—TFs were shown to produce He4 that was captured in the lattice structure [6]. There was no gas phase He4 measurement, there was no ejecta, no crater, but exposed TF MS measurement of He4 was found in the exposed Ti TF lattice. When Ti exposed the four pieces of the TF from the active zone were melted in vacuum conditions, where the melted foil gave up its He4. The Ti foil was compared to two BCC Pd exposed TF lattices. There was no He4 above background in the 2 Pd BCC TFs (all target foils have small amounts of measurable He4 and these are measured and subtracted as background) [6].

3.4. The natural background He4 in the FCC TF lattice craters. Was it a problem?

A discussion of the background He4 that was naturally found at low concentrations in all materials such as TFs. It was one of the main sources of He4 that must be considered in MS He4 measurements. An important determination was how much He4 was locked in the TF lattice and was liberated into the cavitation water via crater debris. And how much can be removed for analysis during an RF run. This He4 comes from looking at the debris of the BCC TF. SEM photos and visually observation crater event debris appears chunky so the amounts measured for total background atoms of He4 in a TF was removed crater lattice where the He4 content can find its way to the gas phase volume of the RF cavitating reactor. Each event volume of ejecta from the TF$50 \times 50 \times 0.1 mm^3$has $\sim$(E-12) ppm. In what was the active area of the RF TF area of the same thickness was RF TF/ old TF = .02 of the measurement in the old FCC TFs. The old TF had about the same surface He4 as the RF smaller foil; about 2(E-14)/He4 atoms. The mass lost to crater debris is about 100 u gm and a ratio 2(E-5). A very low percentage of the TF event debris will find its way into the gas phase for the crater debris, which was chunky with an exposed potential on the low side. It is a guess at 1% loss of He4 in the debris of 1 ejecta made it to the gas phase of the reactor, and did not add to MS measured He4.

4. Discussion

4.1. Control of T, P and time of the MC atom environment

The very small clusters of MC deuterons [4] can be attributed to AF forces that draw like charges together (hydrogen ion isotopes are electron size). One can alter what occurs in small event that occurs on the surface of a TF atom by control of the explosive changes in MC parameters. The operating system should be run at the lowest working temperature, as that produces the best cavitation bubbles, see Fig 2. The mechanics of cavitation bubbles wants the vapor pressure of DOD to be low as possible to give the most energy to the MC. The control of the external pressure should be as high as possible without stopping the cavitation process. The period of MC process to occur was in the order of E-14 s in one cycle. Too much pressure kills the cavitation and too much temperature allows the DOD vapor pressure to kill the adiabatic collapse process. The idea is to run the cavitation process as cool as practical with a heat exchanger like the RF system uses.

4.2. The PVDF oscilloscope acoustic measurements

The radio frequency, RF, system was a nonobvious extension of Sonofusion, where a replacement of the oscillator with an RF input in the low MHz range for the disk piezo that functions as an antenna transmitting motion to the PZT piezo. At 2 MHz, the forced movement of the piezo and TF just approximates the zone between the piezo and the TF of ij l. So,it was tuned to a minimum RF reflection and maximum admittance with a standing wave ratio (SWR) close to 1.00 as possible, 1.00 indicating 100% signal transmitted into DOD. There were other tuning methods that can be utilized: oscilloscope voltage maximum, the frequency resonance, the visual D_2O surface water movement, and the oscilloscope overtones producing smaller size bubbles. Some new obvious discoveries about the cavitating system have been made during these experimental years: 1) there was more than one vibrating surface; 2) the fundamental vibration may make some large contributions to the resonant bubble population via overtones; 3) the acoustic signal, f_1, indicates a second frequency was present at about the same amplitude but 17 cycles lower frequency (higher density zone) (See Fig. 5a and b.)

4.3. The driving force of the SW system was the volume ratio $(rD^+/rD^*)^3$

DV/dt was the force driving $D^+ + D^*$ a $^+$ + g (He + SL) or some related path. This same methodology can be transferred to the proton system. It is interesting to observe that three isotopes of hydrogen have these tremendous volume changes in a few fs. 7E+10 times volume changes in ∼6fs. These momentum changes are responsible for big impulses (momentum changes) generated by hydrogen ion or deuteron ion capturing an electron. The Isw was mass 2D kgm*2Datom/rate. And for a comparison the Iμ was kgm*2Datom/rate was the difference in rates and equals E+9 in favor of and a difference impulse of Isw = 0.207 kg*m/s and Iμ = 0.0033 [12].

4.4. SL measurements were of good quality

In the series of 10 to 20 MHz experiments using reactors built for the measurement of SL photo emission varying the MPPC distance radially, the input power, and the MPPC sizes from 100, 400, and 1600 pixels shows a consistency in the measurements. The reactor was a cylindrical PZT piezo shown in Fig. 5b and 5c. The resolution of SL with almost a vertical rise and fast recovery, left most of the cycle, 94%, with no bubble activity (Fig. 5a).

4.5. The low frequency TF damage turns to using higher frequencies

The SEM photos of low frequencies, 20 and 46 kHz, show heavy TF damage and cavity fields with the 1-μ diameter resolidified Pd TF spheres, see Fig. 1. The systems big and large size crater population produce critical damage to the TF. The placement of the TF was important and should ij wavelength from the TF surface. There is activity on both sides of the TF. These systems were just too powerful for practical use, so the option was to go to higher frequencies where the TF damage was less. It brought the focus on the 50-nm crater systems [13].

4.6. introducing the Lawandy's AF system as alternate or coexisting path to alpha

The background for the Lawandy's measurements "like charge attractive forces," AF, starts with the MC, a cluster of like charge deuterons with a very short time frame located on the target foil lattice. Being physically very small it finds itself in-between lattice atoms of the TF (see Figs. 3, 4, and 8). The MC is shown in Fig. 8 as a pink glob and how it compresses on self-destructive path as at the cooling temperatures push the probability of a D+ + e- D* nothing happens for the temperature is too high for a free electron to interact with D+ or a H+ so there is time for the attractive forces to work across the interface. If they are deuterons one might see He4 produced.

4.7. Natural He4 background in TF lattice that could contaminate He4 measurements

The TFs are of the dimensions of $5 \times 18 \times 0.1$ mm with an active area of 35 mm^2. Background He4 atoms in the TFs was about 1 to E+6 TF atoms. The He atoms were distributed in the lattice in small bubbles of 2 to 100 He atoms. The only He we are concerned with those He atoms that are close to the lattice surface structure on both sides. Consider the He atoms in the first 10 layers of Ni atoms. The number TF surface atoms were about E+10 Ni atoms with their He4 atoms of about 1 for each million TF lattice Ni atoms. So, the He4 population would be about E+4 atoms that could possibly be involved in the total He4 MS measurement. This amount is so small it is unmeasurable.

4.8. The duality of the acoustic wave

The RF inputs—particularly at lower frequency where it was easily shown on the surface of TF the colorful TF surfaces—produced standing wave patterns in the active TF areas, sometimes very subtle or sometimes very gaudy, as a permanent addition to an exposed surface of a TF. These standing wave patterns give information etched into surface resonance pattern. TF 100-μ thick drumhead gives acoustic information via resonance patterns areas and intensity gradations that showed the input frequency and the area of TF surface exposure area. The 2-dimensional area at 46 kHz displayed the 3mm wavelength that were used with smaller foils at these higher frequencies. They were part of the progression into the high frequency cavitation processes that could also produce He4.

5. Summary

Looking at an alternate path with Lawandy AF system for the MC in the process producing alpha appears compatible with the SW impulse path. And it shows RF cavitation of water at about 2 MHz should produce MS measurable He4. The MC deuterons profit from Lawandy's image like charge attractive force and its ability to maintain a high-density interstitial MC system.

There was a connection made from old work that carefully measure SL photons were applied to current RF work that were not measured at the same time, but the conditions were expected to produce SL. The RF system was too complex to run in the dark. One can look at the basic equation 2D He4 + g and see all its basic parts. They were not produced together but they do fit with a little push.

Figure 6g and Ref. [3] show how the RF Acrylic machined reactor was put together where the geometry was different, cavitating 80 ml DOD and removing heat with a coolant flow in a copper coil. The power to RF piezo antenna was from a 50-watt linear amplified signal and TF 0.020 inches above; see Fig 6a. The PVDF plastic strip measured the acoustic character of system is shown in Fig 6a. The 50-watt linear amplified RF signal powered the reactor piezo antenna. The radio frequency interference prohibited any TC measurements while in the experiment was in the run mode. Therefore, a duty cycle 30 s on and 5 s off, was installed in power circuit for all uncorrupted temperature measurements during the 5-s off mode.

In several inches of cavitating water in the 1.5-inch diameter Acrylic column was a 60-Ohm heater that was used to calibrate the DT in the running mode that was matched to the calibration mode. To reduce the reactor DT a heat exchange system of Cu coils one for the reactor the other in a coolant of 3.5 L of water where reactor heat was removed at a constant water flow $\sim$2ml/s. This reduced the running temperature to a lower DT for more efficient cavitation. This was shown more clearly in paper [12].

Different cavitation frequencies stimulate DOD to produce different size and energy spectrum bubbles. SEM photos of TFs with surfaces exposed to different frequencies, 20, 46, and 1600 kHz, show that Ro bubble size changes from 40 to 1 micron [1]. There was evidence of MC at the low frequencies, 20 kHz, the cavitating system SEM photos show the small 50-nm radius craters were found at all frequencies. In the RF MHz systems, the bubble implantation and MC was not so robust, leaving the target foil surface melted but intact with major TF surface defects still in place. The MC serves as the local of activity on TF surfaces were both SW and AF can initiate their paths to alpha production. There were measurements for He4 by MS where care was exercised to prevent any air retention or leakage. The errors of measurement are about 10% for the small amounts of He4, and the calculation of MeV/He4 atom ratio in the RF runs was closer than expected.

The MC fit to the AF system developed by N. Lawandy in the timeframe required was tight but other than that looks like a good working environment. There was a comparison between the SW mechanism impulse, Isw, and the muon, Iμ, a system that has proven to produce He4 at rates as slow as E+6/s [12]. The result of this comparison show the Isw is the order 100 times stronger.

It is interesting to observe that the three isotopes of hydrogen have these tremendous volume changes, dV/dt, in a few fs. 7E+10 times volume changes in $\sim$6fs [12] of the muon system was a slow rate, 1E-6 sec, compared with the SW system [12]. These momentum changes are responsible the big impulses generated by hydrogen, deuteron, and tritium ions electron capture.

The addition of the PVDF strip (Fig. 6a, opposite the piezo in the reactor) gives a continuous view of the waves and interference patterns in the DOD and TF in the reactor. The piezo target foil geometry in the running mode produces different densities on either side of the TF. This produces 2 zones of different densities and a wave system with a 17-frequency beat. If the beat was there during the run the system, it was a good environment for alpha production. The interrelation of cavitation densities of DOD that influence the velocity of acoustic wave lengths and produce beats and information about the TF and piezo geometry and gap (see Fig. 5a and 5b). Running the acoustic oscillograph channel gave one confidence that the system was working. Figure 1 puts all the cavitation experiments together showing trend changes as the frequencies were increased.

The big picture shown in Fig. 1 is often over-looked as the cavitation frequency changes.

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