Transmutation by Dust Fusion

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Abstract

Test results will be shown for transmutation experiments. The simplest is the so-called Oshawa chain when only carbon and air are the initial materials. However, the heavier isotopes also take part in the reaction chain. The heaviest end products, as Fe, Cu, Zn, are not found in all test results, but Si, Ca, Al are abundant.

When zeolites were tested no new materials were observed, but their ratio changed significantly.

The radioactivity of uranium salts was also influenced. The gamma radiation decreased, but beta radiation increased during the tests.

The treatment of highly radioactive byproducts of nuclear power stations has been a known concern for decades. Its solution is deceptively simple today: to store the waste for tens of thousands of years. Needless to say, this is not the only possible way out.

As radioactivity is a fundamentally nuclear phenomenon, the key to the solution is to meddle with the structure of the nuclei, that is, with the stability of nuclei.

Our aim has been just a modest feasibility study: is it possible to influence the radioactivity of a given nucleon? The answer is a cautious yes. LENR methods seem to give hope for an economical way to treat highly radioactive waste.

A nucleon can be unstable for the lack or for the excess of neutrons. All elements above iron and cobalt contain more neutrons than protons since they act like a "nuclear glue." Heavy nuclei above bismuth are always unstable; they decay via a long chain of radiation events. During their decay, gamma radiation is a common event, and it is dangerous because shielding is expensive. Therefore our aim has been to reduce gamma radiation and to explore its feasibility.

The technical method available to us was nano dust fusion, one of the many forms of LENR. In nano dust fusion, transmutation may take place from the lightest to the heaviest nuclei via Coulomb shielding. The principle of dust fusion is simple to grasp: in a plasma, fast moving electrons are trapped under the solid surface of a floating tiny dust particle. The mass of a dust particle is immensely higher than that of an electron. Therefore these dust particles are practically stationary, while electrons—especially in an acoustically resonant plasma—are very fast. Even in a stationary cold plasma, thousands of electrons are trapped in a dust grain. Consequently, their surface potential—electric field intensity—is extremely high. This extreme field intensity makes possible fusion via the Coulomb shielding between positive ions (Figure 1).

Thus different positive ions may fuse together and several fusion mechanisms may take place, depending on the substances present in the plasma. When hydrogen is present, along with carbon dust, then protons or deuterons are accelerated towards the negatively charged grains. When the accelerated proton has a higher than 0.7 MeV energy, neutron formation may take place as $p + e + v \rightarrow n_1^0$. Neutrons then may take part in several further reactions. Light nuclei may also fuse, like the Oshawa reaction family.

The other possible mechanism is spallation: when light positive ions are accelerated, they hit the atoms of the dust particles. Due to Coulomb shielding and acceleration, heavier nuclei might crack and lose some of their nuclei. Thus formerly unstable heavy elements like uranium and radio isotopes may crack into smaller, more stable fragments.

These were the initial assumptions for our experiments. Now let us examine some actual test results.

Transmutation Experiments

Brief Technical Description

The dust fusion reactor consists of three essential parts:

1. Variable power, and preferably variable frequency power supply.
2. A cylindrical or spherical electromagnetic cavity resonator. See Photos 1 to 7 showing various power supplies, spherical and cylindrical electromagnetic resonators.
3. An acoustic cavity resonator made of high-purity quartz (spherical or cylindrical). The plasma is created only inside the latter, and the dust to be treated is also placed here. The device is always ignited by heating a thin carbon rod, usually 4 cm x 0.5 mm. (See Plasma Photos 1 to 5, and Photos 8a and 8b, showing the acoustic resonators.)[1]

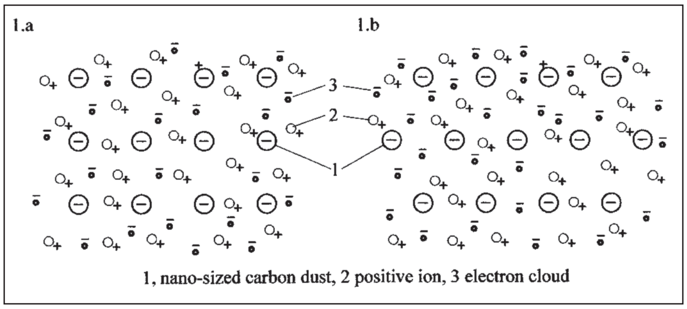


Figure 1a and 1b. Schematic view of near equilibrium rectangular crystal (or dusty) plasma. Small micron or nano-size negatively charged dust particles are in dynamic equilibrium with the neighboring plasma. Positive ions are attracted to the surface of the dust particles, they may take an electron and leave it as a neutral atom or oscillate collectively on the surface. This configuration is a dissipating, energy consuming media, of no direct practical interest. The particles can be of any shape, and their distribution of size is usually non-uniform.

In most of our tests, the pressure was usually atmospheric, the gas was usually air, though in a sealed acoustic resonator several gases were tested at different pressures.

Our first power supply was essentially a microwave oven. This is a 50 Hz device with a 50% duty cycle. Later two iron transformers were used at 100 Hz. Thus there were shorter periods between the plasma ignition and cooling periods.

At first, the multimode rectangular electromagnetic cavity resonator of a household microwave oven was used, at about 1200 W.

When a quartz tube (20 cm long and 22 mm inner diameter) was used as an acoustic resonator with both ends open and a little belly, there was a loud sound and the Oshawa reaction chain was observed. Here carbon and air (nitrogen and oxygen) are fused in a number of combinations, and the intermediate products also take part in the chain of secondary and tertiary reactions. A number of fusion products are possible due to the large number of their possible combinations. All of them were found except phosphor. Primary products are more abundant than secondary products, and tertiary reactions yield even less, because rare isotopes, ^{18}O, ^{15}N are required. The carbon, oxygen, nitrogen triplet yields a number of possible fusion reactions, shown below. No other material combinations seem to be so good. Maybe He, Be, C triplet is also useful, but technically difficult, and Be powder is dangerous to handle. Some of the reactions are as follows:

primary reactions	secondary reactions	tertiary reactions
$^{12}C + ^{12}C \rightarrow ^{24}Mg$	$^{24}Mg + ^{16}O \rightarrow ^{40}Ca$	(only with ^{18}O, ^{15}N)
	$^{24}Mg + ^{15}N \rightarrow ^{39}K$	
$^{16}O + ^{16}O \rightarrow ^{32}S$		
$^{16}O + ^{15}N \rightarrow ^{31}P$ (not found)		
$^{12}C + ^{16}O \rightarrow ^{28}Si$	$^{28}Si + ^{16}O \rightarrow ^{44}Ti$ (unstable)	
	$^{30}Si + ^{18}O \rightarrow ^{48}Ti$	$^{48}Ti + ^{15}N \rightarrow ^{63}Cu$
	$^{30}Si + ^{16}O \rightarrow ^{46}Ti$	$^{48}Ti + ^{18}O \rightarrow ^{66}Zn$
$^{12}C + ^{15}N \rightarrow ^{27}Al$	$^{27}Al + ^{14}N \rightarrow ^{41}Ca$	
$^{13}C + ^{14}N \rightarrow ^{27}Al$	$^{27}Al + ^{27}Al \rightarrow ^{54}Fe$	
	$^{27}Al + ^{14}N \rightarrow ^{41}Ca$ (unstable)	
$^{12}C + ^{14}N \rightarrow ^{26}Al$ (0.71Myear)		

And the strangest of all, suggested by E. Esko and A. Jack[2]

$$2\,(^{12}C + ^{16}O) \rightarrow ^{56}Fe \text{ (-2 protons due to spallation?)}$$

Most probably all reaction products formed oxides, otherwise K, Al, Ca must have evaporated instantly, like P. The evaporation losses could not be measured in our tests as they were not trapped and analyzed in these experiments.

We used high grade reactor graphite in our tests. Some of the graphite is burned in the presence of oxygen of course. However, there were usually some small spheres in the ash after two to three minutes of operation, and they were fer-

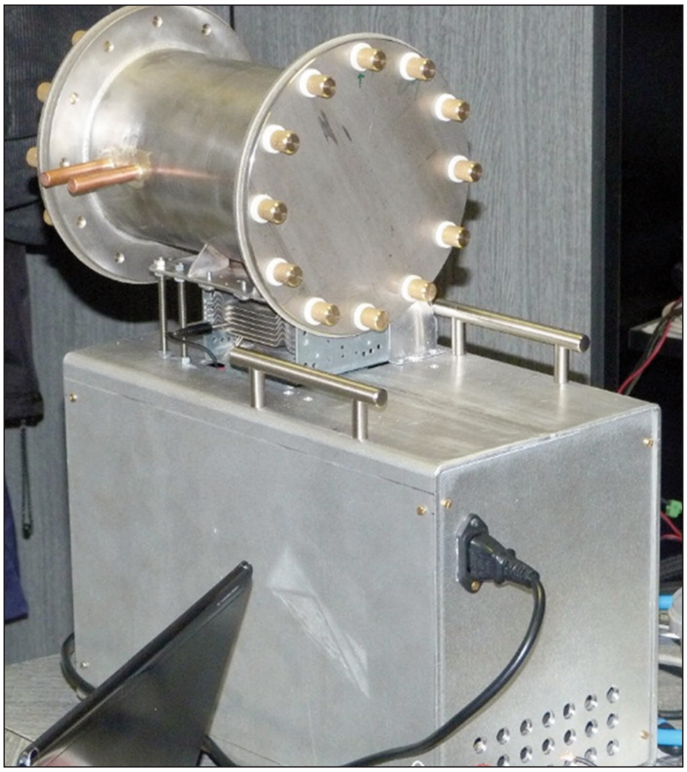


Photo 1. Transverse electric cavity resonator.

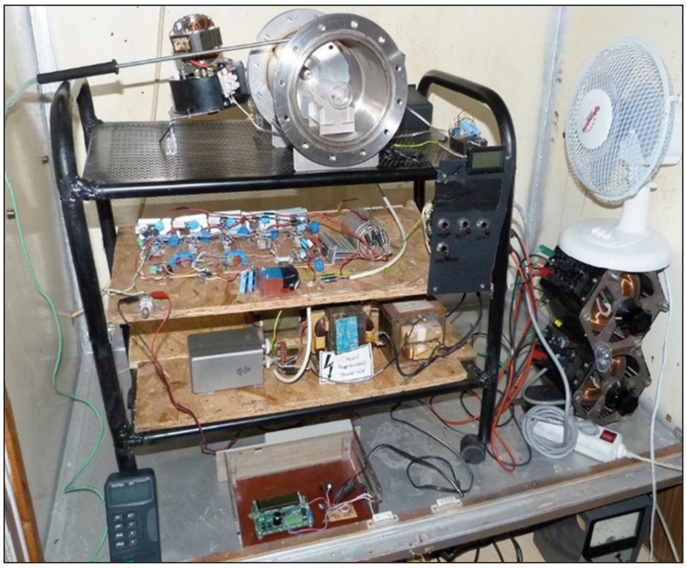


Photo 2. Transverse magnetic cavity resonator.

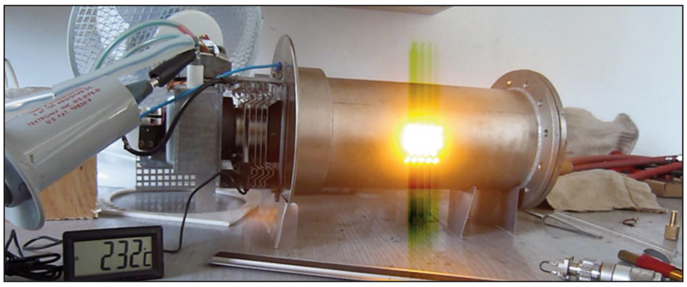


Photo 3. Transverse magnetic electromagnetic cavity resonator, with ignited oscillating plasma.

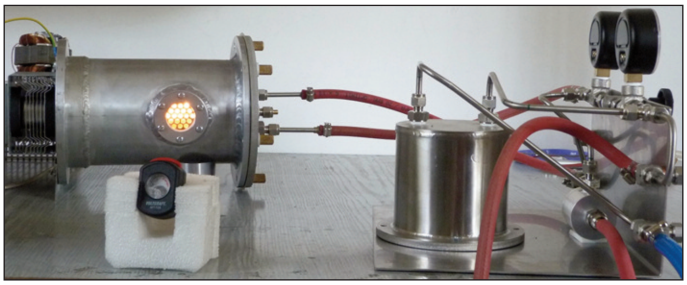


Photo 4. Another transverse magnetic cavity resonator, at low pressure.

Table 1. EDX analysis of ten grains of each element involved in the Oshawa reaction.

Element	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Average
C	13.6	9.84	33.3	21.4		16.67		22.98	12.71	19.11	21.01
O*	27.3	23.5	32.9	38.7		36.27		32.79	39.28	39.64	36.0
Mg	0.99	1.47	0.64	1.18		3.81		1.95	1.4	1.92	1.82
Al	4.48	8.15	3.41	5.78		8.92		8.42	20.78	11.89	9.87
Si	44.9	44.87	21.67	23.86		22.6		21.4	18.6	17.17	20.89
K	0.68	0.64	4.49	5.68		2.47		3.83	2.28	2.49	3.54
Ca	1.09	2.07	0	0		3.46		0	0	0	
Fe	6.85	10.93	1.93	1.95		4.48		6.67	4.25	5.47	4.13
Cu	0	0	0	0.87		0.72		1.17	0.69	0.85	0.72
Zn	0	0	0	0.75		0		0.8	0.0	0.89	0.41
Ti	0.56	1.28									
S	0.03	0.23									

romagnetic.

Electron beam microanalysis confirmed the presence of Oshawa reaction products, even some sulphur was observed due to $^{16}O + ^{16}O \rightarrow ^{32}S$.

There is an alternative route to Fe, not spallation but fusion: $2\ ^{27}Al \rightarrow ^{54}Fe$, which is a rare iron isotope (6% of natural abundance).

Copper might fuse in the reaction $^{15}N + ^{48}Ti \rightarrow ^{63}Cu$, which demands the rare (0.5% abundance) ^{15}N isotope. This is a typical tertiary product, because titanium ostensibly arose from the fusion of Si and oxygen, but silicon might come from the quartz wall of the acoustic resonator as well.

The route to ^{64}Zn (about 0.5% natural abundance) might be similar: $^{48}Ti + ^{16}O \rightarrow ^{64}Zn$.

There was no $^{16}O + ^{15}N \rightarrow ^{31}P$ reaction observed in this test. Most probably because the ash was washed before the EDX tests, or simply as a result of evaporation. Phosphor is usually present in all test results when air plasma is used in the experiments.

This is a relatively simple chain of fusion events, which perhaps is the easiest to reproduce in open air at atmospheric pressure with fine graphite powder.

In Table 1, ten grains of the above materials were analyzed by EDX (Electron Dispersive X-ray). All materials were part of the Oshawa reaction chain. Two test results with the highest and lowest deviations, samples 5 and 7, were removed from the data set. (*The presence of oxygen is due to trapped/absorbed molecules. The amount of silicon is not reliable, as a fraction of it may come from the wall of the quartz acoustic resonator. The scattering of the data is apparent, and Ca or Zn, Cu are not present in all samples.)

EDX results for samples 1 and 2 are shown in Table 1a, before treatment. Nevertheless Mg, Al, K, Fe is present in all the treated samples.Unfortunately isotope distribution cannot be determined by EDX. Only the best mass spectrometers are suitable for that, and we had no access to them.

Table 1a. EDX results for samples 1 and 2.

	Sample 1	Sample 2
C	54.93	83.69
O*	45.07	16.23
Fe	-	0.08

The probabilities of the above reactions are quite differ-

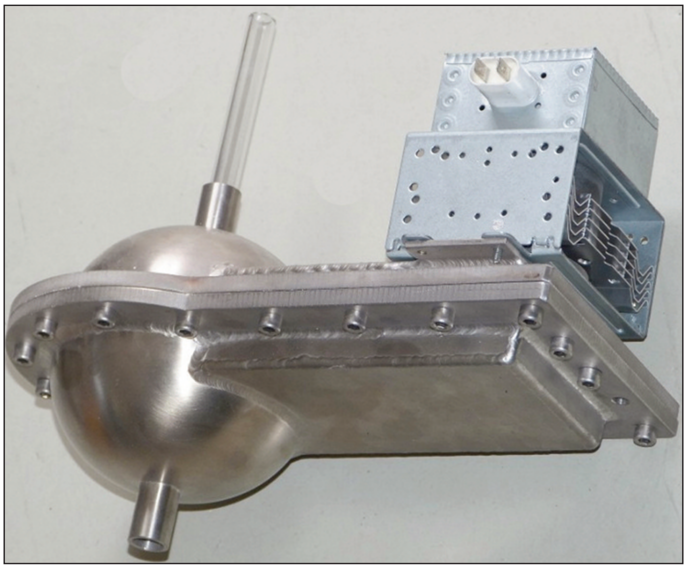
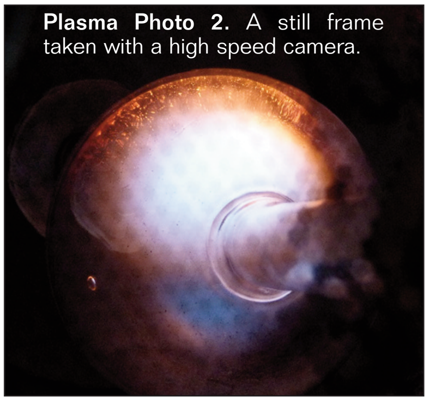
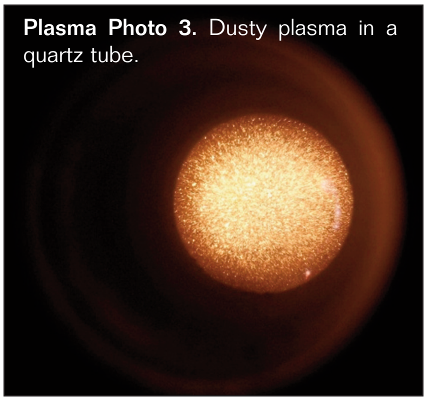


Photo 5. Spherical shaped transverse magnetic cavity resonator, with mounted magnetron.

Photo 6. Experimental set up with previous spherical transverse magnetic cavity resonator.


Plasma Photo 1. Plasma in quartz sphere at 2 kHz.


Plasma Photo 2. A still frame taken with a high speed camera.


Plasma Photo 3. Dusty plasma in a quartz tube.

ent. For example, the C + C → Mg reaction is less likely, because there is little carbon vapor in the plasma. The most probable source of carbon in the plasma comes from the cracking of a CO_2 molecule. The most likely reactions are those containing nitrogen.

Indeed, the presence of Al as a primary fusion product is apparent, in about 10% in the ash (the treated sample), but Ca is visible as a possible secondary and tertiary product, and potassium (^{39}K, about 3.5% abudance) is apparent in each tested sample. Again, if neutrons are synthetized, then $^{40}K + {}^{14}N \rightarrow {}^{54}Fe$ is possible.

Certainly a sensitive mass spectrometer would clarify many uncertantaities about isotope distribution of the treated sample.

However there is another fact: there are no other elements except those of the Oshawa chain, because Na, Sc, V, Cr, Mn are absent. The chain of reactions is like a Lego toy. The starting elements C, O, N, Si are finite so the possible variations are also limited. Moreover, there is an upper limit; above Fe, Cu, and Zn, new elements cannot form due to the lack of neutrons. If more H or O were added to the initial gas, the outcome might have been different but mixing air and hydrogen isotopes is dangerous. Perhaps adding water vapor H_2O is a safer route for this experiment. Nevertheless the carbon-based Oshawa chain of fusion reaction is a proper method to prove: light element fusion up to Zn is relatively easy to perform via the Coulomb charge shielding effect of carbon dust particles. See Figure 2 for the real chain of fusion events, though phosphor is absent in the test results.

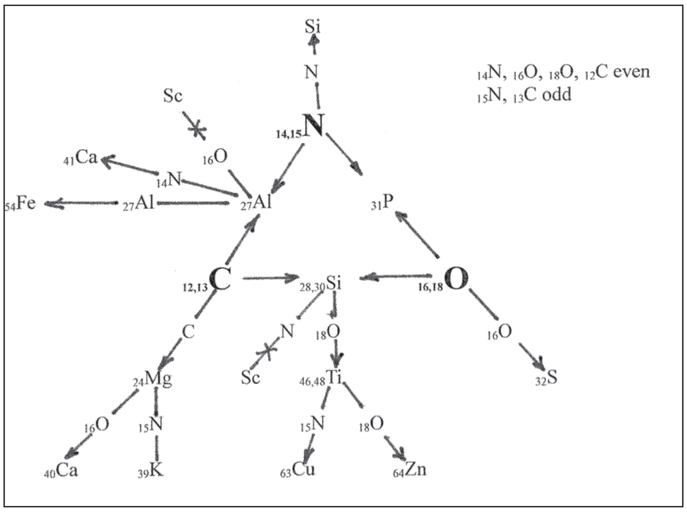


Figure 2. Chain of fusion events starting from light and heavy isotopes of N, O and C. Phosphor was not found, and Sc cannot be formed due to the lack of neutrons. Final fusion products: Ca, Fe, K, Cu, Zn, Mg, Ti, S and Si. No other elements are predicted, no other products are found in EDX tests (10 samples).

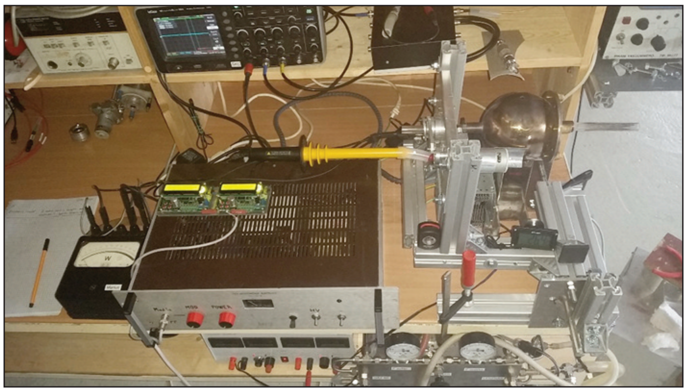


Photo 7. Spherical transverse magnetic cavity resonator made of steel plate.


Photo 8a. Used acoustic resonators.


Photo 8b. Broken acoustic resonators.

The delicate energy issues are not treated here. There is no overall extreme energy release. Parts of the reaction chain could be energy producing, while others consume endotherm energy. This is an unexplored territory. Daniel S. Sumski's "Least Action Nuclear Process" theory seems to rule this weird world.[3]

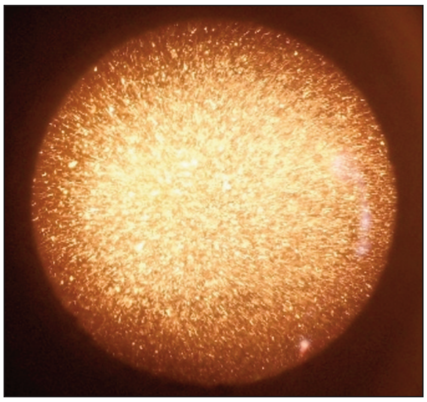
The physical process—the fusion of light elements—is the same as in an arc welding process. However, the efficiency, the "yield," is much higher due to the several resonant processes of dust fusion.

There are many important details and technical know-how which is crucial to maintain high efficiency. For example, the diameter of carbon dust particles is among the important parameters, as there is a sharp optimum value. Grains that are too small burn quickly, as there is a competition between the physical process (fusion) and the chemical one (combustion).

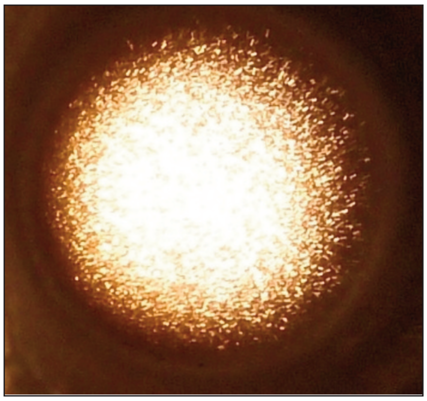
As we had very limited access to EDX, we were unable to carry out a systematic study of the light element fusion.

No significant energy release was observed but fusion of elements heavier than carbon do not yield a significant amount of energy. Nevertheless, no attempt was made to perform calorimetry. Further, no significant gamma radiation was observed during the tests at about 20 cm from the device. There was no chance to measure α and β radiation during the tests.

Afterwards there were no tests of radioactivity, which might have been negligence, as it turned out later.



Plasma Photo 4. Enlarged picture of the plasma, taken at 900 frame/sec.



Plasma Photo 5. The same plasma picture taken at 1200 frame/sec.

Transmutation of Zeolites

The Oshawa chain of reactions starts just from three light elements, and the heaviest fusion products were just above iron, that is Cu and Zn. The question is obvious: is it possible to go beyond them towards heavier elements? There is already a commercial profit at the next line of the Mendeleev periodic table, because it contains some industrial catalysts, such as ruthenium, rhodium and palladium.

The electron cloud of these elements contains one more layer, and of course the Coulomb shielding must be more intense, so the technical challenge is tougher.

At these higher masses, the neutron deficiency of the nuclei are more pronounced. It is difficult to find light ingredients which add up to proper stable isotopes. This is still possible according to our test results, not discussed here, but it is not a routine, repeatable experiment at this modest technical level.

However, the elements of the next line are impossible to fuse from lighter elements. Nuclei of rhenium, osmium, iridium, patinum and gold contain so many neutrons that they probably cannot be fused from lighter elements. However, spallation from heavier elements—like lead, bismuth, thorium or uranium—seems possible.

The next series of experiments, involving a wide spectra of elements found in zeolite minerals, explored the feasibility of spallation, and fusing of elements heavier than iron.

There was an additional purpose of the experiments: to test the validity of the symmetry-based solid crystal nuclear model of L. Sindely, which is similar to Norman Cook's model.[4] The nucleus is not a shell or liquid drop, but a symmetric lattice of nuclei. According to this model, the shape of nuclei has a periodic symmetric lattice structure and layered like an onion, and there is a striking relation between them. A lighter nucleon has the inner core of nuclei, and a heavier nucleon contains it embedded as a lower layer or seed. When an iron nucleus is covered by nuclei, the next closed layer is achieved at ruthenium, and the next layer is osmium, which all happens to be in the same column of the periodic table. The same is true for triplets like Ni, Pd, Pt, or Cu, Ag, Au. These groups of elements are usually found in the same ores in mines, so probably they were formed together but the starting nuclear "seeds" were the light ones.

Zeolites are minerals rich in light elements, and available in finely ground powder. They were chosen for both features. In these tests, formation of new elements was not observed, but the abundance of the elements changed significantly. This is not in correlation with the melting and evaporation of the silicates and oxides of these light elements. Both fusion and spallation might have taken place simultaneously.

The most significant changes took place again in air at atmospheric pressures. (The zeolite-graphite dust mixture was treated later at higher air pressures as well. The composition tests were not performed then with ICP-mass spectrometer, but with a less reliable X-ray spectroscope. Increased pressures showed a higher transmutation yield, up to about 1.5 bar. At even higher pressures, the volume of the plasma decreased, as we were unable to increase the input power.)

Next let us show a set of test results taken by mass spectrometer, which is considered as significant, in Table 2.

Before we jump to any conclusion, there are some important additional remarks. The same test was a complete failure (no change in composition) in several other experiments

Table 2. Zeolite test results with mass spectrometer. (*in mg/kg , **Samples dissolved in HF, while the rest in H_2SO_4, HCL.)

Element	Li	B	Na	Mg	Al**	P	S	K	Ca	Ti**	Cr	Fe	Co	Ni	Cu	Zn	Rb	Sr	Y	Zr**	Nb**	Mo	Sn**	Cs	Ba	Sm	Pb
Before*	60.4	46.6	643	1920	14600	126	586	12500	13200	424	7.3	6990	206	36.1	21.2	142	101	123	142	101	6.85	2.75	13.5	64.2	84.2	23.5	3520
After*	7	108	484	1140	21300	103	<10	3170	16100	620	60.1	7400	6.4	39	1060	191	16.6	69.8	101	142	127	5.1	64.5	9.52	39.2	1.52	1160

at lower pressures, higher carbon grain sizes and additional carbon. (Maybe the dust grains fell out of the plasma?) Anyway, there was no significant difference between the composition of the treated and untreated samples. Although the same power was maintained, the assumed evaporation did not take place.

Some Technical Details

Both the electromagnetic and the acoustic cavity resonators were spherical. Their respective internal and external diameters were 107 mm and 60 mm. The acoustic spherical resonator was supported by a 13/10 mm quartz tube. The zeolite/graphite mixture (about half cubic cm) was administrated via this tube, and rotated by hand during the 3-4 minute treatment. The pressure was kept at atmospheric level. There was a filter in order to prevent the initial thermal blowdown of the dust mixture after ignition. The filter has a hydraulic resistance as well, and prevents the escape of fine dust. The maximum electric input power was maintained manually at about 1200 W. Due to the 60-70% efficiency of the commercial magnetrons, the microwave power was around 600-800 W. Its frequency was kept near the acoustic resonance, which had a sharp value at about 1.3 and 7 KHz. Due to the gradual heating, the density of the gas and the plasma was constantly changing, and the resonance frequency was gradually increasing. This made it difficult to maintain continuous resonance.

The amount of graphite, as compared to the dust to be treated, is also a crucial factor. By experience 1:1 volumetric ratio seemed to be the optimum. The role of the graphite is a sort of grid, preventing the coagulation/welding of zeolite particles. They have a significantly lower melting temperature than carbon particles.

Several zeolites were tested. Some had such a low melting temperature that they were useless for experiments. The one used for our tests is available in pharmacies as a food additive. There were some significant changes for light elements like Li, B but almost no change for "nuclear ash," the most stable nuclei of Ni, Fe, Co.

The strangest test result was for phosphorous, which ought to evaporate and disappear from the system. Yet it was still present in the system after the treatment, unlike sulphur.

The analysis of the result is left to the readers, but the change is apparent for both directions. Fusion is a possibility when there are more materials than before, like the case of B, Al, (perhaps phosphorus) K, Cu, Zr, Sn.

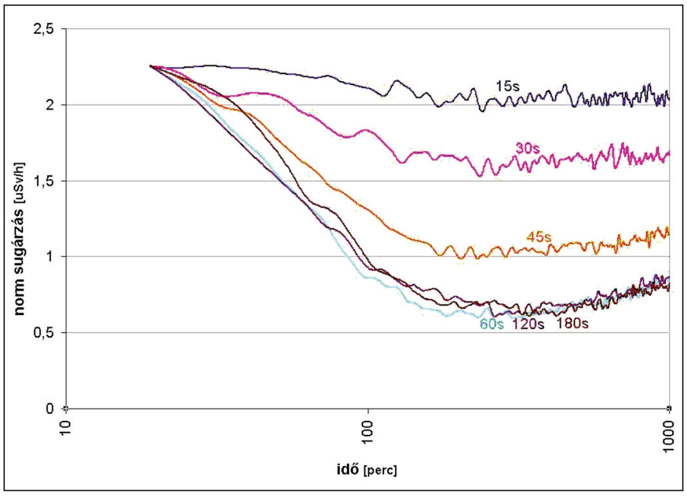


Figure 3a. Gamma radiation after different pump down periods. After about three weeks the radiation returns to the original level.

Heavier elements seem to decrease. Might it be a result of spallation? Or is this just wishful thinking? Ba, Sm, Pb seem to decrease significantly. But this is a different mechanism than the previous C, N, O fusion chain.

So why is there no gold, platinum or other precious metals? For two reasons: they do not add up from the wide spectrum of starting materials, and the lack of neutrons. Further, most probably spallation/fission has its own rules, which are not yet known.

To find out those rules, much more work needs to be done. First the process must be made technically reliable. For example, the sphericity of the acoustic resonator is uncertain, as it is hand-blown, sometimes with significant deviation from a sphere. Consequently the acoustic properties changed from sphere to sphere and sometimes the high amplitude acoustic resonance disappeared. These major problems must be addressed in order to find the rules and parameters of spallation/fission.

Influencing Radioactive Decay Rate

The LENR of light elements is a heresy in mainstream science but any reactions concerning heavy nuclei met the same fate within the LENR community. Nevertheless it may be worthy of describing some preliminary tests involving natural uranium. Natural uranium is mined, it is a mineral (black pitch) containing mostly uranium and some of its decay products like lead, barium, radium and some volatile gases, like radon. Usually sulphuric acid is used to extract uranium from black pitch. After some cleaning, this product is called "Yellow cake." This material (and other uranium salts) have been used as dyes for ceramics and textiles for centuries.

We could get only a small sample (about 10 cm^3) of this medium quality natural U_2SO_4, and some pilot tests were conducted.

Due to the low melting point of this material, a relatively cold plasma had to be applied, at a pressure between 0.5-0.8 bars. At this pressure and at about 1000˚C bulk quartz wall

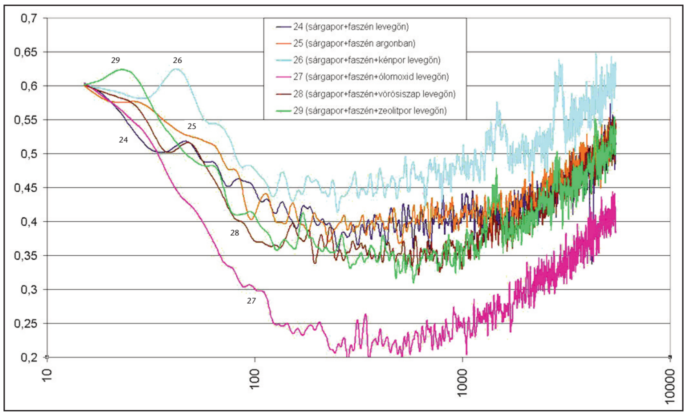


Figure 3b. Gamma radiation of uranium salt after adding different materials to the uranium salt and carbon dust powder. Curve (24) uranium and charcoal in air. Curve (25) uranium salts, charcoal and sulphur in air. Curve (26) uranium salts, charcoal and sulphur in air. Curve (27) uranium salts, charcoal and PbO in air. Curve (28) uranium salts, charcoal and red sludge in air. Curve (29) uranium salts, charcoal and zeolites in air. Horizontal axis is logarithmic time in seconds, vertical axis is gamma radiation in micro Sievert/hour.

temperature, radon is baked out, so γ radiation involving the radon decay chain is removed. However, after about three weeks, radon reaches the initial saturation level again in the uranium salt. (See Figure 3a.)

But when we add some powder containing heavier elements to the U_2SO_4 sample before treatment, the decay rate tends to change. (See Figure 3b.)

There is a clear tendency: the heavier the added nuclei, the lower the γ radiation level of the treated powder. The time scale is logarithmic on Figure 3, so it leveled off after about 3-4 weeks after treatment.

There is a price to be paid for this: the β radiation increases well above the original total radiation level. Since β radiation is easy to screen, while γ is not, this might be a price worthy to be paid.

The heresy lies in the test results, the time dependent radioactivity level can be influenced. It means most probably that uranium (and its byproducts) nuclei can be restructured—most probably by spallation. (See Figure 4.)

Unfortunately no lab will admit any, even slightly radioactive materials, so the mass spectrum of the treated sample cannot be used to prove or falsify this assumption.

In fact, uranium is not a primary concern.

The danger of nuclear reactors comes from their spent fuel. Their cobalt, iodine or barium are the characteristic radiation byproducts. Fortunately they are lighter elements so the chance of transmutation (and thus creating stable elements) is higher. However, such highly radioactive elements are not available. Anyway, their handling requires "hot labs," which were not available to us.

The mere mention of transmutation is alien to mainstream science. Only the small LENR community considers it a reality. Thus the treatment and storage of radioactive waste of power reactors will be a problem for years to come.

Biological Transmutation

Biological transmutation has puzzled the less than handful of scientists who stumbled onto this phenomena over the last two centuries. Obviously, this phenomenon cannot be explained on a strictly chemical basis.

Dust fusion and Coulomb charge shielding may help to grasp the foundations. Any cell is full of microscopic bodies, like mitochondria, or the cell nuclei itself, but even cell membranes have large and uneven surfaces. They float in an electrically conductive liquid, but that is globally neutral—like real plasma. The tiny floating, electrically insulating materials behave as dust particles in a real plasma—they are partially charged. The electric charging of different cell particles is apparent in cell divisions. Thus there is a high intensity electric activity within a cell, especially in the vigorous cell divisions, like the growth of seedlings. Charge accumulation on the surface of cell organs could reach a threshold, where light nuclei, like calcium, might arise from magnesium and oxygen as described before in one of the Oshawa reactions. The uneven electric field build up, and the consequent Coulomb charge shielding, can overcome the fusion threshold, but at a much lower production yield.

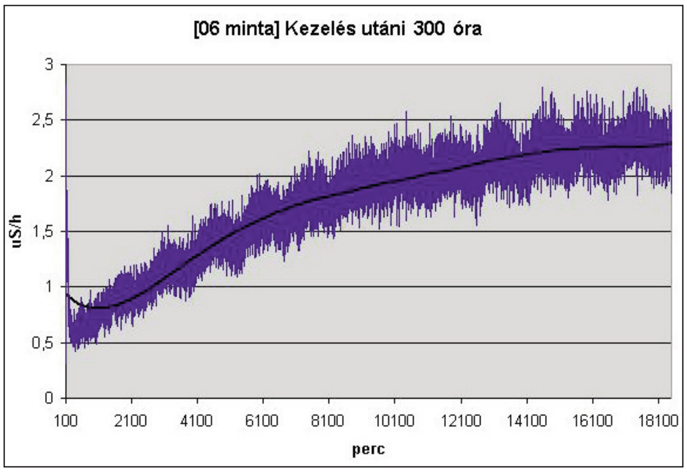


Figure 4. Beta radiation intensity as a function of time. It nearly doubles after a two-week period, and still rising slightly. Most probably neutron rich, unstable carbon is responsible for the increasing radiation. The measurement was terminated after two weeks.

Mountains made by Carbon + 2Nitrogen = Calcium reaction might have been created during the past millenia.

Electrically charged particles or large rough surfaces are the common features of dividing cells, even in bacteria. Dust particles in atmospheric plasma have the same features. These might be the common roots of transmutation in biology and oscillating plasma.

Conclusions

Dust fusion is more widespread in nature, than previously assumed. In the solar corona and in biology fusion transmutation is highly probable.

When/if dust fusion is technically improved, it may have practical applications like manufacturing of rare metals, especially catalysts, reducing the level of radioactive waste, and maybe artificial "on the spot" production of some medical radioactive isotopes with short half lives.

Further, this research may help to find out the real structure of nuclei in the long term. Present mainstream nuclear models are clearly inadequate to describe LENR phenomena, even in well-known effects, like the fission of heavy nuclei.

For light nuclei, from hydrogen to zinc, the fusion seems to be relatively simple, and arithmetic rules it, as there are enough neutrons to form at least one stable isotope after fusion.

But the landscape changes dramatically above the most stable nuclei. With targeted, carefully selected pairs of materials, some important industrial materials like Re, Ru, Pa still can be manufactured on an industrial scale (after proper R&D).

However, even heavy nuclei synthesis seems to be viable via fission or spallation from heavier stable nuclei, like Pb, Bi. The same method can be used for the reduction of radioactive decay, gamma radiation of heavy elements, like uranium, radon, radium. For the lighter and more dangerous radioactive elements in spent nuclear fuel like Cs, iodine, Ba, etc., the theoretical prospects are even better. However, those processes must be fully automated, which is not a simple, but a technically feasible way out of the recent glut of radioactive waste. We can act now, and not leave this problem for future generations.

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