

DETAILED EXPLANATION OF OPTI-SILVER™ AND COMPARISON TO COLLOIDAL SILVER

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Essentially all of the scientific community that is involved in the field of antimicrobial silver understands that the basis for the many industrial and medical products that have come out in recent years, and that continue to come out at a remarkable pace using silver, hinges on the fact that these products release silver ions. It is well recognized that there is an inherent need for specific delivery mechanisms to capture or stabilize the silver ions and then to release those silver ions where and when they are desired, depending on the medium and on the environment where the silver ions are desired.

SILVER IONS DO THE WORK, REQUIRE A DELIVERY MECHANISM

It is a well known fact in science that it is the silver “ion” that kills germs and heals tissue, and that neutral silver atoms are inert and have no bioactivity whatsoever.

In physics, an element such as silver can only exist as either an atom or as an ion. An ion is an atom that’s missing an electron.

It is also well known that silver ions are extremely unstable and that in order to “deliver” them to where you want them you need a method of stabilization and a controlled release.

This is illustrated perfectly in a 2006 article by Dr. Herbert Slavin, MD, director of the Institute of Advanced Medicine in Lauderhill, Florida, entitled “Ionic Silver – The Powerful Defense Against Viruses and Other Microbes” (<http://www.silverfacts.com/powerful.pdf>). In that article, he cites quote after quote from major news stories and press releases from major industrial and medical companies. Here is just one segment of his article, in which he quotes from The New York Times:

Our growing understanding of this area of controlled delivery has contributed greatly to the increase in the number of products using ionic silver for antimicrobial purposes. The New York Times stated in a December 2005 article, “Silver, one of humankind's first weapons against bacteria, is receiving new respect for its antiseptic powers, thanks to the growing ability of researchers to tinker with its molecular structure.” What this refers to is the deliberate formation of molecular structures that will release silver ions in the given environment at the desired rate.

The same article goes on to say, “But silver's time-tested – if poorly understood – versatility as a disinfectant was overshadowed in the latter half of the 20th century by the rise of antibiotics. Now, with more and more bacteria developing resistance to antibiotic drugs, some researchers and healthcare entrepreneurs have returned to silver for another look. This time around, they are armed with nanotechnology, a fast-developing collection

of products and skills that helps researchers deploy silver compounds in ways that maximize the availability of silver ions – the element's most potent form. Scientists also now have a better understanding of the weaknesses of their microbial adversaries.”

SELECTION OF THE TRANSPORT AGENT

The manner in which silver ions are released by the stabilization-and-transport agent is dictated by the agent that you marry the silver ion to. The selection of that agent determines how readily the silver ion will be released in the presence of other agents competing for it through electrochemical attraction.

“Colloidal” silver is simply a mechanism to achieve this necessary stabilization and release – or delivery – of silver ions. It consists of microscopic particles of silver metal – inert silver atoms – and, according to most manufacturers of colloidal silver, it may also contain some silver oxide and/or silver hydroxide. The silver oxide and silver hydroxide would contain some silver ions bound up as a component. Upon ingestion of the product, some of the silver metal will undergo a change-of-matter process in the body and release silver ions, and some of the silver oxide and silver hydroxide will, likewise, release some silver ions in the body. It is mainly the silver oxide that is the transport agent in colloidal silver. However, only very miniscule amounts of silver can ever be released as silver ion in the body from silver metal, silver oxide, or silver hydroxide.

As well as colloidal silver may work, it's an extremely limited approach since, firstly, only a marginal percentage of the silver that is introduced to the body is in the form of ions and, secondly, the components are not at all conducive to releasing that portion of the silver which is indeed ionic. Additionally, colloidal particles – whether we're referring to silver metal, silver oxide or silver hydroxide – are not soluble in water, which further makes it a very poor vehicle for delivering silver ions in the blood, which is water-based. [[Don, is it indeed accurate to say silver hydroxide is not water soluble, or should we limit that statement to colloids and to silver oxide? – Jay]]

A SIMPLIFIED EXPLANATION OF ATOMS AND IONS

Silver, a member of the periodic table, is an atomic element. An atom can be likened to the solar system* – it is made up of a nucleus (the sun) and of electrons spinning around it (the planets). An atom has an equal number of protons in the nucleus as it has electrons spinning around it. It is electrically balanced. If you add or remove an electron, it is no longer referred to as an atom. It is now referred to as an ion. It is electrically imbalanced and a myriad of tendencies to interact with other ions are now at play. How those interactions will play out depends on what those other ions are, and on the different kinds of ions in the vicinity competing for one another – which is dictated by the electrochemical attraction that exists between ions of various substances.

A silver atom has 47 electrons (planets) spinning around the nucleus (sun). Silver metal is made up exclusively of silver atoms – metallic silver is atomic silver. The atoms in metallic silver are intact and are not bioactive at all – they're completely inert. Only silver ions exhibit bioactivity.

A silver ion consists of a silver atom that is missing an electron (planet).

A silver ion has a plus-one positive charge. It is generally not possible to add an electron to a silver ion, only to remove one. Therefore, generally speaking, all silver ions are positively charged “plus-one” ions.

A silver ion is extremely unstable and will tend to bind with negative ions that can give it back its missing electron, even if they have to share that electron. The sources of those shared electrons can be a myriad of substances. A silver ion cannot exist alone in the physical world – it will always have something with it that puts it into electrical balance. Different substances have different degrees (or strengths) of attraction to silver ions. There might be virtually no strength to the attraction, as with, for instance, silver nitrate, or there might be a very strong attraction, as with, for instance, silver chloride.

CONTROLLED DELIVERY OF SILVER IONS

As stated above, the trend in utilizing silver in antimicrobial and wound-healing applications in recent years and, for that matter, the uses of silver for those purposes for more than a century by modern medicine and industry (and for centuries back through history), all involves the utilization of silver ions. Silver atoms, the only other form in which silver can exist, are entirely inert and have no bioactivity whatsoever. This is basic chemistry and physics. Any chemistry student with the most basic knowledge knows this to be the case. The descriptive materials and the continual news stories and press releases on the many industrial and medical products introduced in recent times utilizing ionic silver make it very clear that it is only the ionic form of silver that exhibits the bioactive effects associated with silver.

When silver coins were used long ago to protect milk from spoilage, for instance, it was the tiny quantity of silver ions released from the predominantly metallic silver coin that did the work. Silver metal will almost always yield a minute amount of silver ions – environmental conditions will almost always result in some of the silver atoms that comprise the silver metal losing electrons, thus yielding some silver ions. It can be said that the silver metal deteriorates upon exposure to the environment, resulting in it yielding a minute portion of its silver as silver ions.

The reason silver nitrate is not practical for internal human use as an antimicrobial agent is that there is virtually no strength to the bond between the silver ion and the nitrate ion, leaving the silver ion available to bind up with anything in the mouth or digestive tract that has a strong attraction to silver ion. The oral mucosa and entire digestive tract are loaded with such substances, with chloride ion being the most aggressive attractor of silver ion of all substances in the body. Therefore, silver nitrate powder – although it is soluble in water and thus in the blood, and although it is readily available for sale in bulk quantities from chemical supply companies at a relatively cheap cost – is virtually useless for internal human use.

TWO KEY FUNCTIONS ARE REQUIRED

What is needed in order to make the bioactive benefits of silver ions available to the human body for internal use is a mechanism to achieve two key functions:

1. The silver ion must be protected from precipitation – or, to put it another way, from being bound up with chloride ions or other negatively charged ions – as it crosses the oral mucosa and/or digestive tract and enters the blood system. This means the silver ion must be stabilized in such a way that it is not available to substances that would be attracting it.
2. The method of stabilization must of necessity allow the silver ions to become gradually available to be utilized by the body after being transported into the body. The reason gradual, controlled release is needed is to optimally enable the silver ions to provide potential bioactive benefits to the body without first being captured by substances such as chloride ions.

EQUILIBRIUM CONSTANT IS WHAT MATTERS TO A CHEMIST

To a chemist, this all boils down to one bottom-line factor: equilibrium, or the “equilibrium constant” – also referred to as the “dissociation constant.” This is the key, in chemistry, to understanding the characteristics of a molecular substance under various environmental conditions.

The equilibrium constant is what determines how readily the compound or molecular structure will remain intact or stable and how readily it will dissociate or destabilize or in order to release the silver ions and make them available under given conditions.

DELIBERATE FORMULATION OF OPTI-SILVER™

Opti-Silver was designed from the ground up with the specific goal of unleashing the true potential of silver ion delivery in the human body and, in fact, of overcoming all of the limitations inherent in colloidal silver.

The chemistry behind the active components that comprise the Opti-Silver complex is well known. The precise chemical structures of the raw materials and of the resultant formulation are all entirely understood and clear. They were specifically selected for optimally achieving the key goals of stabilization and controlled release of silver ions in the body.

The source of the silver ions when manufacturing Opti-Silver is silver oxide (it is noteworthy that many colloidal silver companies claim that the end result of their production method is silver oxide, and that this is where the process for manufacturing Opti-Silver begins). The silver ions are removed from the silver oxide and incorporated into a complex with citrate and potassium in water.

Dibasic citrate with potassium is deliberately created through the combining of citric acid and tripotassium citrate in a precise, controlled, wholly predictable and understood manner. The

silver ion is then removed from the silver oxide and combined with the dibasic citrate, thus forming silver citrate (predominantly dibasic citrate silver, along with a small percentage of monobasic citrate silver and a small percentage of tribasic citrate silver), with potassium as the counter-ion – the Opti-Silver complex.

The chemical characteristics of Opti-Silver can be calculated and fully understood by a chemist. Specifically, the equilibrium constant can be clearly calculated and, thus, the efficiency of the delivery-and-release mechanism can be readily understood and anticipated.

The silver citrate complex is deliberately made to be water-soluble, and is kept in equilibrium in the bottle and in the blood, through the addition of potassium, which serves as the essential counter-ion. The chemistry is extremely well controlled. Silver citrate alone is not water soluble, nor is it soluble in the blood. However, upon the addition of potassium, silver citrate becomes entirely water soluble and thus entirely soluble in the blood, and exhibits the optimal equilibrium constant for the most effective balance between stabilization and release.

The Opti-Silver complex encompasses a set of factors chosen for the sole purpose of optimizing the two key functions that are required for delivery of silver ions to the human body: stabilization for delivery, and controlled release.

The vast majority of the silver ion content in Opti-Silver is stabilized within the complex in a manner designed to withstand the attempts at attraction by any competing substances in the body until slow release is achieved when desired. A tiny portion of the silver ion is freely available as silver ion to be used by the body right off the bat. While in the bottle, Opti-Silver keeps the vast majority of its silver in a stable, soluble, complexed state and leaves only a very small portion of its silver available as free silver ion. After absorption into the body, Opti-Silver gradually releases more and more of its silver from the complexed state to the free silver ion state.

There are no “particles” in Opti-Silver, since there is nothing agglomerating or clumping together (unlike with colloidal silver). All of the silver in Opti-silver is dissolved in solution in the water.** Opti-Silver is entirely soluble in the blood. One hundred percent of the silver in Opti-Silver is ionic silver, without question. It contains no impurities, only silver citrate with potassium in water. It is entirely consistent from drop to drop.

To a chemist, Opti-Silver represents a brilliant chemical formulation that results in a far more efficient delivery mechanism for releasing silver ions in the body than has ever existed before. The chemistry is simple, clean and well understood – readily appreciated by anyone familiar with basic chemistry and even more so by those with advanced chemistry backgrounds.

INTERNAL HUMAN USE

Controlled delivery of silver ions in the human body is the most challenging of environments. Without the right degree of balance between stabilization and controlled release of the silver ions, they will either bind up with chlorides and other agents in the mouth, digestive tract and blood if the bond with the transport agent is too weak, or they will fail to ever be released in the

body if that bond is too strong. The complicated electrochemical environment of the human body is unique in nature.

Tests on killing germs outside the body reveal almost nothing when it comes to knowing how the product will perform at delivering silver ions into the body. Surface disinfection and tests in a Petri disk are not the same as delivery in the human body – which is why the FDA prohibits any company from using approvals for surface disinfection or tests in a test tube as a basis for making any advertising claims for internal human use. In order for any lab test to have meaning in indicating what to expect in the human body, elaborate steps must be taken to replicate as closely as possible the conditions of the human body.

GENERAL OBSERVATIONS ABOUT COLLOIDAL SILVER

Colloidal silver, which has been used for more than a hundred years, was originally developed by pharmaceutical companies as a way to achieve the two key functions listed above. It is uncertain whether they knew what was taking place on a chemical level back then. All indications are that they did not, and that it was created strictly through hit-and-miss trial-and-error. Indeed, there remains a great deal of uncertainty even today as to the actual chemical composition of virtually all colloidal silver products. What is certain is that some degree of bioactivity resulting from the oral intake of colloidal silver is well established. What is also certain is that, as stated above, the only form of silver that can possibly result in any bioactive benefits in the body is silver in the ionic state. The bioactivity from colloidal silver is from silver ions. The question is how efficiently it provides these ions. The answer is: not efficiently at all.

Colloidal silver manufacturers often claim that their products contain some quantity of silver oxide and/or of silver hydroxide. While it is unclear as to how much, if any, of these substances exist in various colloidal silver products (and it is highly doubtful that the production method used for making colloidal silver was specifically focused on deliberately creating those substances from a chemistry point of view when the method was devised – see below for how colloidal silver is made), we can for the sake of discussion assume that, indeed, most colloidal silver is comprised both of metallic silver (which is entirely inert and exhibits no bioactivity whatsoever) and of silver ion that is bound up in the form of silver oxide and/or silver hydroxide.

Colloidal silver can potentially yield silver ions in the body from two possible sources: either from a portion of the atomic, metallic silver changing into silver ions as a result of some of the silver atoms losing an electron (as with the silver coin in the milk container) or from silver ion being yielded from the silver oxide and/or silver hydroxide component. In either case, it is an obvious fact to a chemist that the efficiency with which colloidal silver yields silver ions in the body is minimal as compared to that of Opti-Silver.

It is a given fact from a chemistry point of view that the majority of the silver in colloidal silver will never be released in the body as silver ions. The vast majority will pass through the body and be excreted without ever exhibiting any bioactivity whatsoever. This is an obvious fact to a chemist for the following two reasons:

1. The portion of the colloidal silver which is metallic, atomic silver will only minimally deteriorate and yield silver ion in the body, just as that silver coin in the bottom of the milk container will only minimally deteriorate in the bottom of the milk container (note that while there is a much higher percentage of surface area in the case of colloidal silver due to the fact that it consists of a large number of very small particles, this doesn't significantly change the fact that only a very minute portion of metallic silver will spontaneously deteriorate into silver ion on exposure to the environment in the human body). [[As stated, a colloid is simply not water soluble.]] – [[Don, is this an appropriate comment to add here? – Jay]]

2. The portion of colloidal silver, if any, which is silver oxide and/or silver hydroxide, is far too stable – the bond between the silver ion and the components that it's bonded with is far too strong – for more than only a very minute portion of the silver ion that it contains to dissociate and be released into the blood before the compound is excreted from the body. To put it in chemistry terms, the equilibrium constant is so low as to be barely measurable, and thus the structure will not readily dissociate and therefore will not readily release silver ions. [[Silver oxide and silver hydroxide are not water soluble.]] – [[Don, is it indeed accurate to say silver hydroxide is not water soluble, or should we limit that statement to colloids and to silver oxide? – Jay]]

The inescapable fact is that most of the silver in colloidal silver remains inert (atomic) or intact (silver oxide and/or silver hydroxide that never dissociates) and is excreted without ever doing anything in the body.

HOW COLLOIDAL SILVER IS MADE

Colloidal silver is manufactured through a process called electrolysis. Two metal rods, one of which is made of silver, are submerged in a vessel of water with the ends of the rods sticking out of the water. An electrolyte is often added to the water to make the water an electrical conductor. (Table salt or baking soda have commonly been used as the electrolyte by many colloidal silver manufacturers.) Wires are clipped to the exposed ends of the two metal rods and electricity is passed across the rods through the water.

As this takes place, the end of the silver rod literally deteriorates into the water, thereby resulting in silver in the colloidal state in the water. It is far from an exact science. The resulting chemical substances are inexact because it is not fully known what the chemical substances are in the first place (colloidal silver companies make claims that are very creative but unfortunately my experience has been that those claims hardly pass muster when scrutinized by a real scientist), and because the chemical makeup of the substances in colloidal silver varies from drop to drop and clump to clump (as does the size of those colloidal particles or clumps).

COLLOIDAL IS NOT NECESSARILY DESIRABLE

When producing colloidal silver, a considerable amount of clumping or clustering (called “agglomeration” or “aggregation”) takes place, and this almost certainly continues to occur in the

bottle over time as well. One reason for this is simply that colloidal silver, by definition, is not soluble in water. Indeed, the term “colloidal” simply refers to minute particles of any substance that are dispersed in a dissimilar medium without actually being capable of being “dissolved” into that medium – meaning it’s just not soluble in the medium (in this case, water or the blood). If you threw a handful of dirt into a glass of water, the minute particles that did not sink or float would be “colloidal” dirt, quite literally. This is the general definition of a colloid, as is known to everyone with a background in basic chemistry.

COLLOIDAL SILVER’S REPUTATION DESPITE INEFFICIENCIES

Nonetheless, there are mountains of testimonials from users of colloidal silver spanning many decades, which we will not dispute at all here. Even with its inefficiencies, colloidal silver has achieved the tremendous reputation that it has. What this demonstrates, if anything, is that even a miniscule amount of silver ion that is stabilized and transported into the body and then released may have the potential to produce truly profound bioactive benefits to the body.

What is of great interest to a chemist is the fact that the efficiency with which colloidal silver achieves this delivery of silver ions in the body is minimal compared to what is possible in light of the drastic increases in our understanding of chemistry over the past hundred years – which is precisely what the structure of Opti-Silver fully brings to bear.

PARTICLE SIZE IS ALL BUT IRRELEVANT

Colloidal silver manufacturers often talk about “particle size” in their product descriptions. This concept is applicable only to “colloidal” silver. There are no particles at all with Opti-Silver, since it is indeed soluble in water and is made to exacting specifications. Particle size with respect to colloidal silver has significance only to the extent that more surface area exists for a given quantity of silver – exactly the same as if that silver coin were broken into millions of microscopic pieces so it can deteriorate more readily on exposure to the environment and release a minute percentage of its silver as ions, albeit a somewhat larger percentage than if you swallowed the silver coin whole.

The amount of surface area and, thus, the very notion of particle size, are also meaningless to the extent that the carrier in colloidal silver is silver oxide and/or silver hydroxide. What matters in that case is strictly the characteristics of the molecule itself – the chemical characteristics of the silver oxide molecule and/or the silver hydroxide molecule, since it’s their ability to dissociate in the body that matters in the first place. How much clustering or agglomerating has occurred (to add to particle size) or has not occurred is virtually irrelevant. [[Is this even true? Roger said: “And when you talk about an assembly of particles [molecules??], you don’t talk about equilibrium constant.”]] What matters is that neither silver oxide nor silver hydroxide are going to release more than a miniscule amount of their silver in the body as silver ions, simply because the bonding is far too strong [[and they’re not water soluble]]. [[Should water soluble be hyphenated?]]

The bottom line is that neither the metallic, atomic silver in colloidal silver, nor the silver oxide and/or silver hydroxide that may also exist in a colloidal silver product, is at all well suited to achieving two key functions described above: stabilizing the silver ion for transport into the blood, and then releasing free silver ions on a gradual, controlled-release basis. [[Is this too redundant?]]

Regardless of the particle size or surface area, the metallic, atomic silver in colloidal silver will yield only a miniscule amount of silver ion in the body at best – just as you can be sure that a silver coin in a milk container will yield only a miniscule amount of silver ion and will for the most part remain as solid silver metal (atoms) with no bioactive quality (no silver ions) at all – while the silver oxide and/or silver hydroxide component is not an efficient chemical structure for releasing silver as silver ions in the blood regardless of the particle size or surface area.

PPM IS ENTIRELY IRRELEVANT

Parts-per-million, or “ppm,” is often discussed by colloidal silver manufacturers. In actuality, ppm is not at all relevant since it just tells you how much water you’re getting with the silver, period – how diluted it is in water. Drink a little more of a low-ppm silver product and you’re in the exact same place you’d be with another product containing the same chemical form of silver that is less diluted in water and thus has a higher ppm of silver. The only difference is you’d be drinking a little more water with the low-ppm product as compared to the high-ppm produce, which of course is entirely irrelevant from a biological perspective. Referring to ppm is only useful in terms of knowing how much of the given product to use, and what you’re paying per mcg of silver if you know how to do the math. Still, all of that is inconsequential compared to how efficient the silver ion delivery mechanism is – which, again, is strictly a function of what the silver ion is married to for delivery and release. The more efficient this delivery and release, the less mcg of silver you need for the desired result.

“NANO,” “IONIC” AND OTHER SEMANTICS

The terms “nano” and “ionic” are now being used with increasing frequency by makers of various silver products in their marketing efforts. These are very sexy terms – especially “nano” – but they have virtually zero meaning until they’re taken into context. It is *all* nanotechnology and is *all* ionic silver whenever you talk about any colloidal silver or any ionic silver product that is orally ingested, simply because it all functions by doing one thing and one thing only: releasing silver ions in the body.

Silver ions are about 0.26 nanometers in diameter – always. The diameter of a silver ion never changes – it can’t according to the laws of physics. The only relevant question is what that silver ion is utilizing for transport and how well that transport agent will carry it and then release it in the body. This is the one key question that any biochemist would ask – “What is being used to carry and release that silver ion?” – and yet it is an area that the vast majority of silver manufacturers apparently neglect to discuss at all in their promotional materials – regardless of whether they refer to their products as “colloidal,” “ionic,” “nano,” “hydrosol,” “mild silver

protein,” or what have you. All of those terms are interesting marketing phrases, but none of them says a thing about the chemistry.

The only thing that matters is the equilibrium constant of the molecular structure being used for transport – for delivery and release.

* For half a century now, modern-day chemists have abandoned the extremely simplistic approach of representing atoms by comparing them to the solar system. Our understanding has evolved to where we now know that it is far more complicated than what is represented by such a simple rendition. Nonetheless, for the purpose of making the concept of atoms and ions understandable for the lay person, this model is still useful and does serve to provide a reasonably accurate view of atoms and ions for understanding just the most basic concepts. For a simple explanation of ions that is more closely in the realm of what most chemists and academicians would consider valid, the reader may want to review the description at <http://www.saburchill.com/physci/chemB/chemB021.html>. (There is also a discussion about ions on Wikipedia at <http://en.wikipedia.org/wiki/Ion>, although this is not generally considered to be a reliable source of scientific information by most chemists.)

** A minute amount of the silver in Opti-Silver will invariably be reduced to metallic silver – inert silver atoms – while in the bottle as a result of photoreaction after prolonged exposure to light. This will occur with any product that makes some of its silver available as silver ions. Indeed, if any product in the field does not exhibit this tendency, it is a strong indication that it is not likely to release much of its silver as ions in the body upon ingestion. The amount of silver that has been reduced to atoms through photoreaction and is no longer a constituent of the Opti-Silver complex is negligible by the time it reaches the end user under normal conditions. It has no affect on the silver that remains in the Opti-Silver complex. As we have stated, atomic silver is entirely inert – it has no bioactive properties at all, is entirely harmless to the human body at normal usage levels, and cannot even contribute towards the build-up of silver that could eventually lead to argyria.

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Dr. Baird is an Associate Professor in the Department of Chemistry at [Nova Southeastern University](http://www.nova.edu). He has served as Chairman of the Department of Chemistry at Florida Atlantic University, where he was responsible for the development and initiation of the chemistry Ph.D. program. He has taught college chemistry for over 20 years. Dr. Baird received his Ph.D. in chemistry from the State University of New York-Buffalo in 1981. He has taught undergraduate courses in chemistry at Western Illinois University and Florida Atlantic University. Dr. Baird has

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DISCLOSURE/DISCLAIMER

Dr. Baird holds a minor shareholder interest in Invision International Health Solutions, Inc., which manufactures and markets Silver 100 and ProSilver 240, both of which contain Opti-Silver as the key ingredient. Dr. Baird is also a member of the Board of Advisors of Invision International.