

IT IS A SORRY STATE OF AFFAIRS THAT AFTER DECADES OF COMPLACENCY, THERE STILL DOES NOT EXIST ANY STANDARD FOR NANOMETRE SIZED SILVER NOR ANY EQUIPMENT AND/OR INSTRUMENTATION FOR ITS PRODUCTION OR ITS TESTING.

Abstract.

During the early part of the 1900s, silver products called colloidal silver were being introduced as a form of alternative medication for a wide variety of infections. Silver per se was already known as an effective antiseptic and biocide. Initial trials in the USA using the so-called colloidal silver to be tested on dogs. Not that the dogs were sick, experimenters at the time ventured to learn how toxic and in what quantities silver was fatal for dogs. How much was learned and what type of silver was used remains a mystery.

The easiest method to produce these silver products were no doubt derived from Silver nitrate, an ionic form of silver produced by dissolving metallic silver in Nitric acid and subsequently reducing it to an alleged neutral silver in water liquid with chemistry. Outside the scope of chemists and chemistry, many individuals tried their hand at a form of electrolysis, making at best ionic silver containing a very small percentage of actual colloidal material. Unfortunately these and other equally absurd practices occur well into the Twenty-First Century. Mainly in the hands of chemists, thinking that nanometre sized collections of atomic silver clusters was a chemical event, no consideration was given, that this material embraces electro-photochemistry in a quantum physics environment. As a direct result of this misconception, no International Standard was ever produced, production procedures were kept a secret and no proper test equipment for quality control and/or adherence to standards ever eventuated. To make the matter of so-called colloidal silver even more obscure, inaccurate descriptions and terminology became the order of the day with words such as particles, dispersions and even AgNPs used in scientific papers. In fact so-called colloidal silver is not strictly a colloid. The purpose of this essay is to set things right, set the scene for a recommended introduction for an International Standard and even more importantly initiate research of the virtues of quantum silver as perhaps the only antidote for the ever increasing risk of the so-called Super Bugs immune to our antibiotics. Proper equipment and affordable appropriate test instrumentation will need to be part of this endeavour.

Key words: quantum silver, linear polarization, light scattering practices.

INTRODUCTION:

After 8 years of intense research into most technical and scientific aspects into the antiseptic and biocidal properties of silver, the conclusion has been reached that after eight decades of trials and errors no real progress has been made. Many universities and groups of scientists have written papers by the thousands without even knowing the material the subject of their research. Even pulverised metallic silver dumped in water, fatalistic to human cells as it is, has been used in many trials. Millions of others have been using variations of electrolysis and electro-chemistry to such an extent that Health Authorities some years back, banned the material as a medicine by Legislation. **And that is where things stand today!** No proper understanding, no consistency, no legitimacy, no standard and no affordable production equipment and testing instrumentation and where do we start to make things right.

Where and how must it all start to end the total confusion?

There must be thousands of ways that so-called colloidal silver is produced. There is the chemical way with reduction material like Sodium Borohydride or even 'green' chemistry added to Silver nitrate, all without much success in maintaining long term stability. Worse still is the use of high voltage ablation (arcing silver electrodes in water) with a possibility of the creation of unstable silver isotopes. Electro-chemistry produced ionic silver would no doubt offer the best yield, if only the material was kept in the dark and refrigerated and irradiated with violet light. Then there are those, who believe in ionic silver and it being 100% pure colloidal material. It really is difficult to start and may be the reason why no one ever bothered at some form of regulation. Whatever material is produced, it cannot even be tested, because as some representative of a national testing laboratory exclaimed "tested to comply with and against what?" That is the situation at present. The chicken or the egg dilemma, which came first? I remember when designing radio transmitters and check their performances. It cannot be done without an accurate wideband Field Strength Meter. The same will be true, but far more complex with standardizing quantum silver and its testing to an acceptable standard.

First things first: identifying what actually constitutes quantum silver.

Our interpretation is simple by this description of the right material: Neutral nano and picometre sized atomic silver clusters in an electrical suspension and without any ionic silver inclusions.

An appropriate specification as to its character would be as follows:

- * Atomic cluster size no larger than 10nm, considered adequate for maximum effect due to the astronomical surface to mass/volume ratio.*
- * Size distribution to vary no more than 4nm.*
- * A Zeta potential of no less than minus 30mV, but preferably higher for maximum long-term stability.*
- * A quantum silver to water ratio of no more than 10ppm concentration.*
- * Produced by either electro-photochemistry or other means of equal quality.*
- * Purity of the silver to be no less than 99.99% pure or better.*
- * Lead and Arsenic content no higher than 10ppb.*
- * Water purity to measure no higher a conductivity than 0.1 Micro Siemens = 10 million Ohm resistivity and total undissolved/immersed solids consisting of either organic or inorganic materials to be no higher than 0.1ppm.*
- * Method of production*
- * What constitutes pico and nanometre sized clusters.*
- * Contained in dark blue plastic containers for long term storage.*

This may seem a formidable task, but relating a concentration of 10ppm as against 1ppm as foreign material would be too high, hence a maximum of only 0.1ppm.

What type of test equipment would be needed most?

1. Concentration level determination
2. Atomic cluster size determination.
3. Cluster size distribution.
4. Zeta potential level

Concentration testing:

This is considered the most important measurement of all and the most difficult. Generally concentration is measured on a Mass spectrophotometer, in particular the 'Inductively coupled Plasma Mass Spectrophotometer' or ICP-MS for short. Extremely precise and expensive to operate, it is nevertheless useless as it cannot distinguish between neutral silver clusters and other forms of silver. Concentration is important as it is directly related to the Minimum Inhibitory Concentration (MIC) i.e. the smallest amount of material required to kill a particular pathogen. Concentration of neutral silver in a liquid suspension of water is generally measured in ppm or mg/l and the general protocol in the laboratory is to start with a particular concentration and initiate dilution practices to arrive at a specific MIC. That type of protocol is not suitable for this material. It would be best if the required MIC can be produced at such a specific ppm or mg/l, i.e. samples of varying concentration of 2ppm, 4ppm. The reason for that is that during production both the silver and the water are affected by the voltages and current applied and to just add water in order to dilute is counter-productive for obvious reasons: the fresh water has not gone through the production process. Since an instrument such as an ICP-MS is unable to establish the concentration of the active material, i.e. quantum silver and nothing else, an alternative and more affordable way of testing has to be sought. This has been found in an electronic discipline called "**Capacitive Reactance**".

Capacitive reactance is a way to determine the amount of actual neutral silver, albeit in pico or nanometre sized clusters, that can nevertheless be used to alter the capacitive reactance in pico to nano farads. Low concentrations would start at the pico farad range and by increasing concentrations of silver would go into the nano farad capacitive range. Inexpensive proto-type equipment has indicated a somewhat linear response with a possible resolution of 1ppm or better.

So-called particle sizing.

Note! It is a weird thing, that whenever science cannot or is unwilling to specify what something is, the word 'particle' even if it is something else altogether, is used. The only time that we can talk about silver (nano) particles, is in the case of pulverised bulk silver that has not gone through the process of ionization and reduction. In the case of electro-photochemically produced quantum silver, the atoms forming clusters are not that different to a bunch of grapes.

Pico and nano metre sized atomic clusters are far too small to be made visible using even a sophisticated optical laboratory microscope. Optical microscopes are limited in their ability to resolve objects below 1 micron (1 millionth of a metre). With the suggestion put forward by some to limit nano metre sized clusters (or particles) to 100nm, i.e. $1/10^{\text{th}}$ of a micron, other ways had to be found to determine sizes. The only and most obvious technology for that is **light scattering techniques**.

Light scattering techniques is the ability of reflected light to scatter in many directions. The smaller and curved the object, the greater the angle of scatter. The reverse is true with larger objects and as size becomes larger the more it will represent a flatter surface and as a consequence

light will scatter over an ever decreasing angle. Any application of photodiode detection will need to consider differences in light intensity with changing spreading or narrowing, Wide scatter will present a lower intensity and narrow scatter a high intensity. An interesting augmentation to light scattering are offered by cross linear polarizing, diffraction and refraction.

Cross linear polarizing.

Cross linear polarizing techniques are a useful tool in the way it allows differentiation between materials that have a refractive index at visible wavelengths and materials that do not, such as the metals silver and aluminium. Linear polarizers work this way: Light entering through a linear polarizing filter, called the polarizer travels through a watery sample containing for instance finely pulverised glass or silica (high refractive index) and silver particles/clusters, these materials will allow light to scatter. However by looking through a second polarizing filter called the analyser and rotated, at some point where the two polarizing filters are at 90 degree to each other, the light scattering of the glass or silica will extinguish, but the light scattering from the metal will continue. A light sensitive detector like a photodiode feeding into an electronic circuit will then be able to measure the quantity of scattered light from both situations and analyse from that an accurate ratio between the two light scattering outputs. For such an instrument, there are some prototypes built, a diffraction grating can be added in order to observe the light scattering at different wavelengths of light and thus an ability to estimate cluster size and distribution. An added advantage will be to position the diffraction grating at 420nm and also see the light scattering of the silver disappear, providing prove that the material in the sample is actually silver. **Please note that circularly polarizing filters will not work in this manner.**

Measuring the purity of water.

Measuring the purity of water in order to determine its suitability for its use, requires a two-pronged approach. One will be the measuring the current due to ionic content (TDI) and secondly measuring the turbidity by matter obscuring light through the sample and complimented by a 90 degree view of available light scattering. It will require a combination of a densitometer and a nephelometer in the one instrument respectively. A prototype of such an instrument has been designed and is awaiting construction and trials

In addition to this instrument a very special piece of equipment has been designed, built and used for a number of years. It boast a very high input resistance of 10,000 million Ohm and operating at 1 volt DC so as not to be affected by parallel resistance or exceed the equilibrium voltage of water and this preventing unwanted polarization of the water. It also contains an electronic circuit, feeding into an average large scale 100 micro ampere panel meter. Good readings of very low conductivity at 1 micro ampere (equals 1 micro Siemens) for deionised water and an almost full scale deflection of between 70 to 90 micro ampere for ordinary tap water. The instrument requires no buffer solution or preferred temperature due to its two 10x10mm (and 10mm apart) silver electrodes.

Measuring Zeta potential

Measuring Zeta potentials that can range from zero volts at the Iso-electric point to a maximum of minus 100 milli volt (mV) is a tall order. The Zeta potential is a static electric (interfacial) charge between the silver cluster and the locally polarized water. Also it is not fixed but a moving electrical charge, surrounded by positively charged counter ions called the Stern potential. Presently Zeta potentials are measured by measuring the speed by which clusters/particles travel using the Doppler-effect, i.e. frequency increase if moving toward or frequency reduction on moving away.

Measuring Zeta potential is very important, in order to counteract the attractive forces of the **van der Waals force**, the Zeta potential (repelling force) must be in excess of between minus 25 and 50mV or higher. An entirely new principle of measuring is needed, more based on analogue principles of electronics, without having to rely on measurement by inference and or complex algorithms. Most likely using very high input resistances and very low current as high as 10^{12} for resistance and 10^{-12} for current (pico ampere/h) and a specially constructed probe with very pure silver sensors.

Production equipment for Quantum Silver

Note! After more than eight years of intense and thorough research and experimentation. It is fairly certain that *electro-photochemistry* is perhaps the most efficient, cleanest and most cost-effective way of producing quantum silver. It only uses the purest silver and water commercially available, combined with a controlled and limited direct current and voltage potential to strip silver ions from bulk silver whilst immersed in water and the simultaneous reduce the ionic silver with photons at 420nm to make the silver neutral again by returning its missing electron. The procedure is totally automatic, just switch **ON** and switch **OFF** when a sufficient level of concentration has been reached. A simple panel meter of 1 mA will show that current will remain (almost) constant, varying by just a few micro-ampere if at all. It will need to occur under refrigerated conditions with no light present other than the intense 420nm light source. Large arrays of LEDs are used to minimise thermal heat and also to ensure that literally **ALL** silver ions are neutralised. Because the use of two electrodes to produce quantum silver even at a concentration of just 10ppm may take several days in just four litres of water, steps have been taken to increase this process sufficiently fast to make the system operate on commercial levels. The first attempt succeeded with multiple cathodes and anodes ALL at the same level of current and voltage at less than 1% deviation, as otherwise it simply will not work. The first experiment provided a factor of 24 times faster and a second attempt a further increase of a factor of three, thus 72 times faster, i.e. something that would require 72 hours to produce would theoretically now only take an hour.

CONCLUSION:

Much needs to be improved by way of methodologies in the practical production as well as in (affordable) testing to a Standard and Quality control. It is obvious that without a stringent quality control in how much silver is used, calculating the end costing of the product will be impossible. Of even more concern, is the present illegitimate position that quantum silver or the so-called colloidal silver finds itself in. Even after something like 'Eight Decades' of complacency by chemists that even today are unable to stop themselves from continuing to use Silver nitrate as their basic constituent to try and produce so-called colloidal silver that is not even a true colloid! The same is true of all of the scientists having had papers published on the attributes of silver without even taking the trouble of identifying the nature of the material used in their experimentation. Why do they still persist in mimicking alchemy as if we are still living in the "Dark Ages"? The time has come to place quantum silver fair and square in the realm of Physics, and Quantum physics at that! Only then is there a possible chance to remove quantum silver out of its 'Doldrums' and start conducting clinical trials on eradicating at least 60% of all infectious diseases world-wide and presently immune to our arsenal of antibiotic.

Who is going to take up that challenge?



It is a fascinating and most of it unexplored Science and Technology!

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