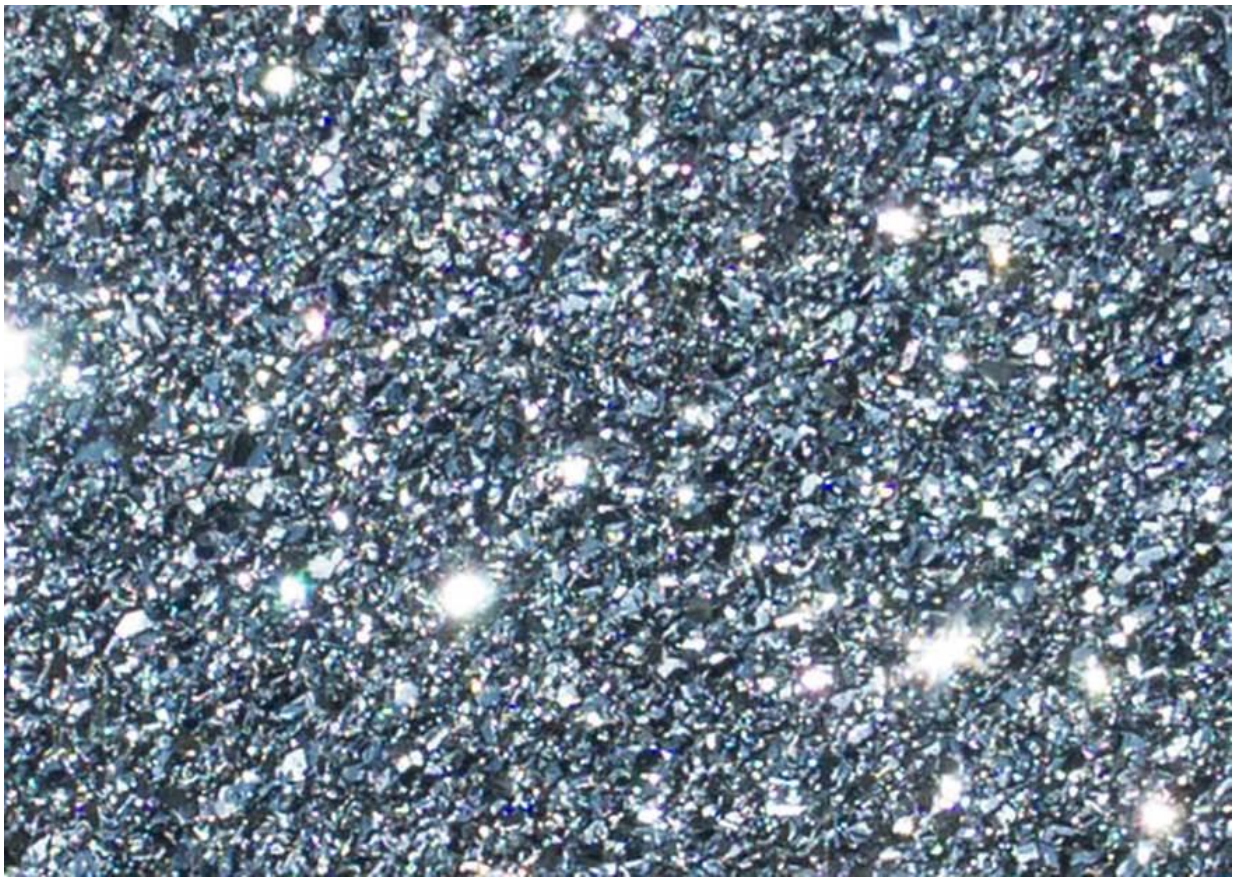
OSMIUM

Processing Guidelines

The intention of this document is to set standards, and to give guidance to the industry on technical and other issues in connection with the manufacturing of osmium jewelry and related products.



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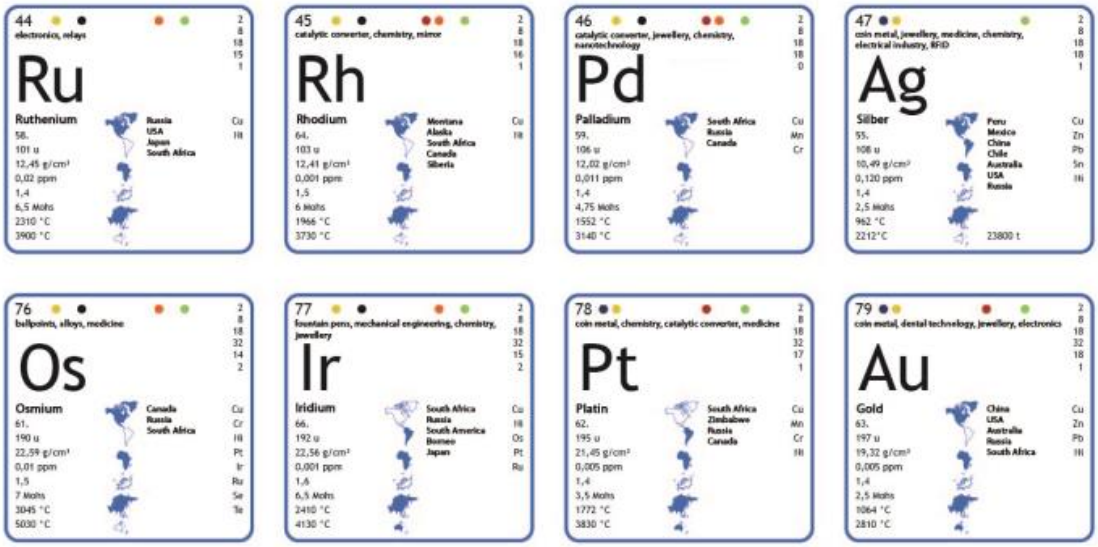
OSMIUM

Basic information

Osmium is a precious metal respectively a noble metal.

There are eight metals in the precious metals respectively noble metals group: Silver, gold, palladium, platinum, rhodium, iridium, ruthenium, and osmium:



Note: Osmium is the last noble metal which is introduced to the jewelry market.

This group of eight chemical elements is referred to as noble metals because of their ability to withstand chemical reactions (chemical inertness) and hence their resistance against e.g. corrosion and decolorization. Within this group, osmium forms part of the platinum metals subgroup due its chemical similarity to platinum. In fact, osmium is mined together with platinum.

Osmium is a very dense noble metal with a whitish-silvery-bluish luster. Osmium is not only chemically inert but also resistant against mechanical scraping. Osmium has gained popularity as more and more equipment and techniques are being developed to facilitate its use as the jewelry metal of choice. Osmium has a very high melting point and is therefore delivered in precut two-dimensional (2D) shapes.

Due to its high specific gravity, products made of osmium are significantly heavier than an equivalent product made of gold. Since its discovery, osmium has been used only in very specific applications because it has exceptional properties. The element with the atomic number 76 has the highest density of all precious metals and also of all other stable elements and substances. It has an extreme abrasion resistance and reflectivity. The properties that osmium develops during crystallization soon led to osmium being dubbed the “unforgeable metal”.

OSMIUM

The myth

Through a series of publications and the ingenuity of traders, customers, chemists and investors, many stories and occurrences in relation to osmium have transpired in recent decades and years, some of which are backed by facts and others that originated from the esoteric market.

At the beginning of this document, we would like to provide some of the facts and explanations to explain, not to transfigure, the myth of osmium.

Osmium was discovered very late and had its first application as filament in light bulbs. These emitted a cozy, soft light. However, osmium was just too rare and expensive to continue to be used in the lighting industry.

Note: The myth around osmium has been further fueled by osmium traders. Osmium is now also known by a number of nicknames, including:

- THE sunshine element
- THE unforgeable
- THE sparkle
- THE resplendence metal
- THE generation metal
- THE eternal precious metal

In many Internet publications and in English speaking regions, it has prevailed that the article before osmium is written in capital letters.

The expression “THE sunshine element” is derived from the whitish-silvery-bluish luster that emanates from the surface already in diffuse light, an effect which is massively amplified when exposed to direct sunlight. Since light cannot penetrate into the crystal structure, it is reflected when hitting the surface. Small surface areas having direct reflection alignment with the human eye can unfold their full reflection effect, whereas other areas of the crystal surface can then only be poorly seen.

For this reason, osmium seems to sparkle, i.e. to shine by reflecting numerous small, light blue flashes when direct sunlight or an LED light source in a dark room hit its surface. As either the osmium object, the light source, or the viewer move, the osmium crystal constantly generates new patterns of reflective surfaces. This phenomenon produces the characteristic osmium sparkling effect, which is unparalleled in nature.

Osmium is also called “THE unforgeable” since all attempts at counterfeiting are bound to fail due to its specific physical properties. There exist a number of publications on this subject on the Internet. This document will discuss in greater detail why security with osmium is particularly high.

The expression “THE generation metal” implies that osmium is usually purchased with longer holding periods in mind to pass it on to the next generation. The osmium investment market is anticipating the so-called osmium Big Bang, the particular point in time when osmium will have completely disappeared from the market and can only be bought from investors. In such a scenario it may be possible to achieve high profits.

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Every precious metal is a chemical element and thus indestructible and endowed with infinite durability. The expression “THE eternal precious metal” stems from the fact that osmium cannot be chemically modified by everyday substances that could lead to its dissolution or damage. There are no acids, caustic solutions or other solutions in which osmium can be dissolved. Unlike silver or other metals, osmium will never “rust” or tarnish.

The expression “THE resplendence metal” was given to osmium in the esoteric market for the first time in Austria. Esoterics credited osmium with special powers such as the ability to “donate life energy”, repel “earth rays” and provide health benefits if worn on the body due to its ability to generate energy flows much higher compared to any other substance.

The first pieces of jewelry on this market actually looked pretty, resembling wristwatches with a small eye in which an osmium diamond could move freely, like floating in a bubble. However, the beauty of jewelry is not a measure of the properties that a material possesses. The only health application of osmium that has been scientifically accepted to date is the treatment of osteoarthritis in joints such as the knee with osmium tetroxide, which is used for this purpose in very small amounts only.

Statements and selling propositions which are often used in the esoteric market lack a scientific foundation, but nevertheless further increase the myth surrounding osmium. The thesis that osmium can repel earth rays (which, of course, do not exist in the electromagnetic spectrum) is possibly based on the shielding effect of osmium against gamma radiation, which is a very real physical phenomenon.

Note: We urge all traders and partners to distance themselves from esoteric statements about osmium and to only state actual facts in a sales conversation; these are truly impressive enough.

OSMIUM

Impossibility to counterfeit

Osmium is entirely dimensionally stable in its crystalline appearance and cannot be changed reversibly by mechanical or chemical means. This characteristic distinguishes it among other properties of easily malleable gold. A significant advantage arising from this property is the fact that osmium cannot be counterfeited.

Its crystalline surface is recognized with extreme reliability similar to a fingerprint.

Explanation:

The unique structure of the friction ridges of a human finger is used for the recognition of a fingerprint.

For osmium, the edge of any single crystal is the analogue to the friction ridges. Every single such edge is inclined in three-dimensional space, forms a specific angle with the level metal bottom surface and also has a clearly defined surface. Also, each crystal sticks out of the base material with a clearly identifiable length.

Even a standard 3 mm osmium diamond contains already more than 1,000 such macroscopic features. At the microscopic level, there are millions of features. For a larger surface area of an osmium structure, the number of variables multiplies accordingly.

For this reason, while a 10,000-fold higher security in comparison to a fingerprint is often mentioned, the actual security is many times higher. Exact numbers cannot be given as, in case of doubt, ever smaller structures could be considered.

When gold is forged, a piece of metal of comparable density is often covered with a more or less thick gold coating. Alternatively, a gold ingot is filled with another metal.

For osmium, only one metal is known that differs from osmium in density by just a few hundredths of a gram. This metal is iridium. However, no forgery can be carried out with iridium either, since not only have both metals high melting points but coating them at these temperatures also means that the other metal would lose its shape. However, this case is just hypothetical, because osmium is delivered in very thin structures as bars so that a real “interior” does not even exist.

Attempts to crystallize iridium ingots must also fail because iridium has a different crystallization structure so that it is clear and visible to the naked eye whether it is ruthenium, iridium or osmium ingots respectively bars.

Note: With the additional security through the density, therefore one can justifiably claim that osmium cannot be forged.

Purity (fineness) and chemical inertness

The raw osmium which is used in the crystallization process has already a purity of 99.99%. During crystallization, this purity is further increased by at least a factor of 10 to 99.9990% up to 99.9995%.

Osmium is resistant to corrosion and decolorization by all common and oxidizing acids. Typical acids are hydrochloric acid, sulfuric acid, nitric acid, and phosphoric acid. The experiments were carried out with concentrated acids and dilute acids with increased hydrogen ion activity and very low pH levels.

Chemical determination of osmium

Note: This section has been adapted from German article Aufschluss (Chemie) as published on Wikipedia (download: 7 June 2018).

Leaching is a method in inorganic chemical analysis in which poorly soluble substances, very often oxides, silicates or sulfates, are converted with the aid of leaching agents into a compound which is soluble in acids or water.

One way of detecting osmium is via osmium tetroxide. A simple detection mechanism would be the characteristic odor of osmium tetroxide, which is not recommended due to the toxicity of osmium tetroxide. However, chemical detection methods are possible. A sample containing osmium is combined with benzidine or potassium hexacyanoferrate solution on filter paper. With benzidine, the paper turns violet in the presence of osmium tetroxide, and bright green with potassium hexacyanoferrate.

In modern analytics, these detection methods do no longer bear any importance. Today, osmium cannot only be detected by means of instrumental methods such as neutron activation analysis, voltammetry, atomic spectrometry or mass spectrometry, but can also be quantitatively determined with high accuracy. NMR spectroscopy and X-ray diffraction allow the structural analysis of organic and inorganic osmium compounds.

Specific settings and the calibration of employed measurement devices are important for detecting osmium based on electronic methods. Equipment needs to be calibrated with real osmium samples, otherwise false measurements may be produced indicating the presence of iridium instead of osmium.

Fine osmium in crystalline form has a purity of 24 karat in the karat system. There are no other alloys used during crystallization. Osmium alloys are used in insignificant amounts in some industries. A prominent example is the prototype meter in Paris, which contains 7 kg osmium.

Note: In summary, crystalline osmium does not change its color, its crystalline structure or other critical properties.

The weight of osmium diamonds is sometimes indicated in carat, similar to carbon-based diamonds. Due to their small size, this unit of mass equal to 0.2 grams certainly makes sense in the metal segment, as well. The fact that the weight of osmium diamonds is indicated in carat is because the first osmium diamonds are already used in jewelry instead of conventional diamonds; therefore, the carat unit may be used by jewelers when quoting prices.

At this point it should be clearly mentioned once again that the osmium diamond has no relation to the carbon-based diamond except its reflectivity in sunlight.

Osmium pieces having a round shape with 3 mm diameter are referred to as osmium diamonds because they can be set into premium jewelry in a way similar to conventional diamonds.

Analyzing osmium specimen in non-wet chemical regimes

Note: This section has been adapted from German article Röntgenfluoreszenz (X-ray flourescence) as published on Wikipedia (download: 7 June 2018).

X-ray fluorescence (XRF) is a common method for analyzing osmium. It is based on the emission of characteristic secondary (or fluorescent) X-rays from a material that has been excited by high-energy radiation. The phenomenon is used in X-ray fluorescence analysis for the determination of the elemental composition of metals, glasses, ceramics and other materials.

Exposing materials to short-wave X-radiation may lead to emission of one or more electrons and hence ionization. If the energy of the radiation is high enough, electrons are knocked out of the inner shells in addition to the bonding electrons. As a result, the electronic structure of the atom becomes unstable and electrons of higher shells fall into the gap created while emitting radiation characteristic of the element.

OSMIUM

Excerpt from the chemical analysis

EAG LABORATORIES

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P.O.#

Date of Analysis 21-nov.-2017
Customer ID: Os

Job # F0HH8412
Sample ID: F171115022 - CB
Issued on: 22/11/2017

échantillon d'Osmium

Element	Concentration [ppm wt]	Element	Concentration [ppm wt]
Li	< 0.005	Pd	< 0.01
Be	< 0.005	Ag	< 0.01
B	< 0.005	Cd	< 0.01
C	-	In	< 0.01
N	-	Sn	< 0.005
O	-	Sb	< 0.005
F	< 0.05	Te	< 0.005
Na	< 0.005	I	< 0.005
Mg	< 0.005	Cs	< 0.005
Al	< 0.005	Ba	< 0.005
Si	< 0.005	La	< 0.005
P	< 0.005	Ce	< 0.005
S	< 0.01	Pr	< 0.005
Cl	< 0.01	Nd	< 0.005
K	< 0.05	Sm	< 0.005
Ca	< 0.01	Eu	< 0.005
Sc	< 0.005	Gd	< 0.005
Ti	< 0.005	Tb	< 0.005
V	< 0.005	Dy	< 0.005
Cr	< 0.005	Ho	< 0.005
Mn	< 0.005	Er	< 0.005
Fe	< 0.005	Tm	< 0.005
Co	< 0.005	Yb	< 0.005
Ni	< 0.005	Lu	< 0.005
Cu	< 0.005	Hf	< 0.005
Zn	< 0.01	Ta	< 5
Ga	< 0.01	W	< 0.05
Ge	< 0.01	Re	< 0.05
As	< 0.01	Os	Matrix
Se	< 0.01	Ir	< 0.1
Br	< 0.01	Pt	< 0.1
Rb	< 0.005	Au	< 0.5
Sr	< 0.005	Hg	< 0.1
Y	< 0.005	Tl	< 0.5
Zr	< 0.005	Pb	< 0.5
Nb	< 0.005	Bi	< 0.01
Mo	< 0.005	Th	< 0.001
Ru	0.45	U	< 0.001
Rh	< 0.005		

H, C, N, O recommended by Interstitial Gas Analysis (Internally equipped)

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Soldering osmium and extreme temperatures

When exposed to extreme temperatures, crystalline bulk osmium forms osmium tetraoxide, which is also abbreviated to osmium tetroxide. This process only starts at temperatures above 400 °C. In addition, airborne osmium particulates, powder and dusts may slowly form osmium tetroxide at temperatures below 400 °C (673 K), including at room temperature:

$$\mathbf{Os + 2O_2 \rightarrow OsO_4}$$

Therefore, osmium can be soldered safely at temperatures below 400 °C. Upon request, the Osmium-Institut zur Inverkehrbringung und Zertifizierung von Osmium GmbH can provide results of a study from an accredited laboratory examining the oxidation behavior of osmium as a function of temperature.

In general, solder adheres well to osmium. The employed soldering iron needs to be able to indicate the peak temperature at the soldering tip because heat is dissipated slowly for small workpieces. In experimental setups, the formation of osmium tetroxide has not been observed for soldering temperatures not exceeding 450 °C.

When exposed to higher temperatures above 500 °C, osmium transforms slowly into osmium tetroxide. The melting point had therefore to be determined under vacuum since it is practically not achieved when osmium is melted while exposed to atmospheric oxygen.

In principle, one can think of the crystallization of osmium in a similar way as the crystallization of carbon into diamonds when manufacturing synthetic diamonds. Likewise, diamonds are oxidized under intense heat and eventually transform into carbon dioxide. The word *diamond* goes back to the Greek word *adámas*, meaning “the invincible”. Fire will transform this “invincible” gemstone into carbon dioxide above 850 °C.

Diamonds, like graphite, are made of pure carbon and are therefore flammable. Unlike diamonds, bulk osmium cannot burn. Airborne osmium particulates, powder and dusts, however, are a flammable solid.

Note: Currently, approx. 40 tons of synthetic diamonds up to a size of a few millimeters are produced per annum. This is about 330 times higher than the amount of crystallized osmium.

The formation of osmium tetroxide, resulting from excessively high temperatures and/or the presence of oxygen, is noticed as a pungent, chlorine-like odor.

Note: Hot soldering operations or any other works with osmium at temperatures exceeding 400 °C are not permitted as per these Processing Guidelines. In case the characteristic odor of osmium tetroxide is noticed, the works need to be suspended immediately and the workshop must be aired.

Cutting osmium by means of Electrical Discharge Machining

It is possible to cut osmium by means of Electrical Discharge Machining (EDM), also referred to as wire cutting, or with a water jet.

The water jet method results in coarse and inexact cutting edges and should therefore only be used when precutting osmium bars or when an overcut needs to be removed during crystal growth. In theory, water jet cutting is many times faster than wire cutting, but the lack of precision renders this method unfeasible for cutting osmium.

The wire cutting process has become the accepted method of choice due to its very high precision. Unfortunately, it is costly and expensive. To date, alternative methods do not exist since osmium has one of the highest abrasion resistances of all substances. The precision of the wire cutting method is demonstrated by recently cut osmium microstructures. These structures are very intricate and deviations from the intended cut geometry are in the range of just one thousandth of a millimeter.

For wire cutting, as with any method, the cutting track needs first be set and programmed in a CAD system to minimize the osmium cutting losses between individual shapes. Shapes and their inverse shapes are ideal because most material will only be lost at the edge of a bar or a disk. An example of this is the osmium diamond and its geometric inverse, the osmium star.

In the cutting track some osmium will be lost on the cutting wire, which cannot be recycled. As the cutting track is extremely small, the loss of osmium is also very small. Therefore, this effect does not have to be calculated.

Hydrochloric acid (10%) is used in order to clean the osmium from the residues of the erosion wire.

Basic facts about Electrical Discharge Machining

Note: This section has been adapted from German article Drahterodieren (wire cutting) as published on Wikipedia (download: 7 June 2018).

Wire erosion, wire cutting or Electrical Discharge Machining (EDM) is a high precision machining process for electrically conductive materials that uses the principle of spark erosion: A series of electrical voltage pulses creates sparks that transfer material from the workpiece to a continuously rolling thin wire as well as to the separating dielectric medium. The wire is then disposed of. The accuracy of the method is based on the fact that sparks always jump at the point at which the distance between the workpiece and wire is minimal.

Cutting process

The erosion wire is wound on a spool and is guided from there via deflection rollers and the brake roller to the upper wire guide. Two opposite drive rollers pull the wire with a defined wire tension ranging between 5 and 25 Newton and a speed of up to 25 m/min (depending on the material) through the workpiece and through the lower wire guide. The wire is then disposed of. The wire guides above and below the workpiece guide and support the wire and suppress vibrations. Furthermore, the wire guides provide a defined deflection point for conical cuts.

The basic rule is that the wire is positively poled and the workpiece is negatively poled. The resulting electro-migration removes material from the workpiece (metal ions are positively charged). When recutting, the polarity may be different or changing, depending on the technology employed by the respective machine manufacturer.

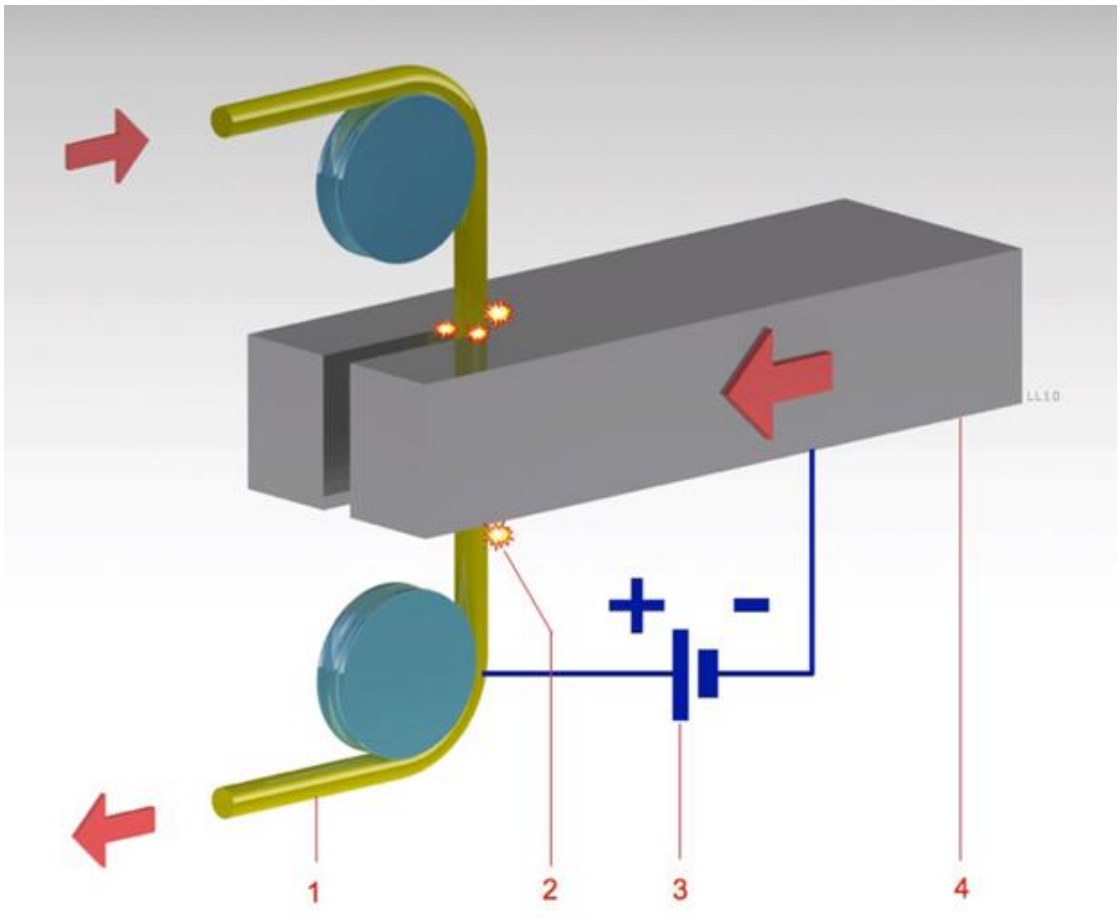

Figure: Basic setup for wire cutting (1: Wire, 2: Area of wire erosion, 3: Voltage source, 4: Workpiece)

As soon as the erosion wire approaches the workpiece at a very small distance, an electric field is formed at the position with the shortest distance. In this field, positively and negatively charged ions are strongly accelerated. These ions form an ionized channel between the workpiece and electrode that conducts electricity. Now the ions collide in the discharge channel, resulting in a visible spark. At the

same time, a gas bubble forms from the evaporating dielectric and the material (electrode and workpiece). In the gas bubble, the pressure increases evenly and a plasma is formed.

The bubble enlarges until it is spatially confined by the electrode and the workpiece. Now, the current is interrupted by initiating a pulse break and the bubble implodes. This implosion tears molten material from the workpiece and also from the electrode. If the pulse break is initiated too late (pulse duration too long), an arc may occur, resulting in a torn wire.

The settings of the generator for the operator are specified by the manufacturer. These include e.g. discharge time, discharge break, current and voltage (also open circuit voltage), capacitor capacity, working voltage (servo voltage), maximum feed and the basic generator circuit (mode or pulse mode).

The maximum generator power of wire cutting machines is usually given in terms of roughing power in mm^2/min. There are now machines that work with up to 500 mm^2/min. However, since such velocities are difficult to control and reduce profitability, the main cut or roughing cut (cut through full material) is carried out at 150 mm^2/min to 250 mm^2/min. A reference height of 60 mm applies.

Often, recuts are performed with lower generator settings to achieve higher accuracies and better surfaces. To achieve accuracies in the range of less than 2 microns, recuts may occur up to eight times, depending on the manufacturer.

Further erosion methods are sinking and drill erosion. The wire erosion machines are usually designed as a C-frame and have five axes. The machine table carries out the X and Y movement and the upper head, which is attached to the Z axis, performs the U and V movement (U parallel to X and V parallel to Y). By working together of X, Y, U and V, so-called 4-axis contours are possible, e.g. a square on the bottom side and a circle on the upper side.

Brass is used as wire material in most cases. Also, materials such as copper, tungsten and steel are increasingly employed. To increase cutting performance and accuracy, EDM wires are coated with zinc and other materials and/or thermally treated. The standard diameter is 0.25 mm in Europe and 0.2 mm in Asia. Due to their low tolerance (1 µm to 2 µm), EDM wires are available in the range of 0.02 mm to 0.33 mm. Latest developments allow the use of two different wire diameters in one processing sequence.

By means of wire cutting, all conductive materials can be processed independently of their hardness. In contrast, processing times are long and the associated costs are high. On the other hand, extremely small cutting widths are possible even for greater material thickness. The machined contours are sharp-edged and meet highest requirements in terms of accuracy.

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Grading osmium semimanufactured materials and finished products

The characteristics of osmium depend on the particular batch. Differences predominantly relate to layer thickness and/or the specificity of the crystallization process.

Whilst diamond grading is a subjective task due to the variety in naturally occurring diamonds, there exist internationally accepted standard methodologies to reduce subjectivity.

Example: The osmium diamond

Grading is intended to quantitatively and qualitatively describe a diamond's unique characteristics so that any diamond can be identified by its individual grading report. Grading is simplified for osmium diamonds because the diamond does not need to be polished, but is delivered ready to set into jewelry with or without an alignment "bump".

Nevertheless, there are two characteristics that make up the quality of an osmium diamond.

First, the quality is determined by the characteristics of the crystal surface structure of the osmium diamond and the regularity of that surface structure across its entire surface. Currently, a standard is under development with which this aspect of quality can be expressed in terms of numbers. Second, quality is determined by the layer thickness of the osmium diamond.

Assessments pertaining to the quality of osmium diamonds can be made internationally only by the certified and well-trained Osmium-Institutes. These should be consulted whenever the grade of an osmium piece needs to be determined.

There is currently a training program under development to enable certified companies to grade osmium diamonds themselves.

For placing on the market, however, every piece of osmium to be introduced to the market can only be certified in Germany and entered for the first time in the database with its Osmium Identification Code.

OSMIUM

Osmium pearls

Osmium pearls are spherically shaped three-dimensional objects consisting of a thin osmium layer crystallized on a spherical carbon substrate. The thickness of the layer ranges typically between 0.5 and 1.5 mm.

An osmium pearl is not meant to imitate a natural pearl made up of alternating concentric calcareous concretions which may form by chance in various saltwater and freshwater mollusks.

Interestingly, however, an osmium pearl is formed in a similar manner. It grows around a crystal nucleus, which is made of carbon having a perfect round shape. However, the process does not take place at saltwater or freshwater temperature, but under extreme pressure at extreme temperatures.

Note: Historically, all discovered pearls are of natural origin. Already a century ago, the supplies of natural saltwater pearls started to deplete. Even today, these pearls are very rare. They are often traded at international auctions as investments. For this reason, the even rarer osmium pearls are a perfect alternative to conventional pearls.

Grading of osmium pearls

Unlike gemstones such as diamonds, there is no universal international standard for assessing the quality of pearls. Diverse systems have been developed for this purpose. Beauty is the main criterion when choosing a pearl. However, there exist evaluation criteria for estimating quality such as color, brightness of reflection, luster, shape, size and surface finish.

For all of the above criteria for assessing the value of a pearl, there is one important factor that is often underestimated. It is said that no two pearls are the same. That is why it is particularly challenging to find matching pairs of pearls for necklaces or earrings.

This difference exists for osmium pearls, which are each perfectly round, only in the form of the crystallization surface, which is used for quality determination.

Note: Since the crystallization process for osmium is standardized, the differences between individual osmium pearls are not very high, but still visible.

When determining the weight of the osmium pearl, the weight of the inner carbon sphere is subtracted to obtain the net weight of the osmium contained in the pearl as well as the gross weight, i.e., the sum of the weights of the carbon sphere, the crystallized osmium and the functional jewelry findings.

The following grading characteristics may be applied for judging the quality of osmium pearls:

- Maximum crystal height
- Layer thickness of osmium on the carbon substrate
- Similarity (homogeneity) of the crystals in the visible crystal structure
- Errors caused by crystals broken out of the structure
- Cracks in the structure of the crystal surface
- Spalling around the process-related opening in the osmium surface respectively the cannulation for applying functional jewelry findings for e.g. studs or chains

Further helpful tips for judging the quality of osmium pearls include:

- Check the osmium pearl for cracks in the crystal structure. These appear as dark areas, where the underlying graphite substrate can then be seen.
- Check the osmium pearl for reflectance differences across the entire surface.
- Determine the largest protruding crystals and their abundance across the entire surface.
- Check the cannulation(s) for cracks and accuracy.
- Determine the weight of the entire osmium pearl and compare it with the weight of the substrate to determine the actual osmium quantity.

Note: Similar criteria can be applied for judging the quality grade of osmium three-dimensional objects other than osmium pearls.

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Processing methods for the conventional manufacture of osmium jewelry

Joining and setting: The easiest ways to combine respectively join osmium with other jewelry workpieces is to set an osmium 2D shape or glue it on level surfaces. Chemical reactions of the osmium with adhesives that affect the osmium are unknown.

The setting of osmium 2D shapes into jewelry is more straightforward than with conventional diamonds, which have a pyramidal or conical shape after cutting of the raw diamond. Thanks to its flat overall structure, osmium can be easily set and worked into creative jewelry pieces of almost any shape.

Note: Solder can be chemically removed from the osmium surface, e.g. by dissolving the jewelry piece in an acidic environment that does not harm the osmium, but removes the solder.

Processing methods: Osmium is brittle and **NOT** malleable like gold or silver. It is not possible to make adjustments to the size of an osmium ring.

The shaping of the osmium takes place exclusively during crystallization, during which an osmium surface with a unique crystal structure is formed in two or three dimensions. The only possible modification to this surface is the subsequent cutting by means of EDM. Osmium is therefore purchased in finished geometries or ordered in the desired shape or cut by means of EDM as described in these Processing Guidelines. Accordingly, osmium cannot be processed in sheets and the diameter of an osmium small curved bar or ring cannot be changed.

It is not possible to saw osmium due to its extremely high abrasion resistance and the risk of breaking crystals out of the surface structure.

Attention: Annealing of osmium is absolutely forbidden, since osmium tetroxide will definitely form at the extremely high temperatures that are generated during annealing!

On the other hand, osmium may be “ground off”, e.g. when removing the alignment “bump” from osmium diamonds. As the “grinding” in fact breaks microcrystals out of the surface structure rather than being abrasive filing, the cut will always be very coarse.

In general, it must be differentiated whether osmium is actually ground off or whether crystals break out the surface.

A diamond file cannot grind off the surface of osmium due to the high abrasion resistance, but instead breaks microcrystals out of surface structure. This has the appearance of filing, where actual material is removed due to material of the file being more resistant to abrasion and dimensionally stable.

When “grinding”, use diamond grinding wheels. Sanding and polishing are processes that cannot applied to osmium, since the existing crystal structures have perfect gloss and perfect smoothness. Sanding would break microcrystals out of the surface structure parts and possibly even destroy the entire piece of jewelry.

OSMIUM

General design guidelines

Since osmium can be damaged by improper handling, this fact must already be taken into account when designing jewelry.

The property of breaking out large crystals is independent of the extreme abrasion resistance of osmium. The abrasion resistance refers to the surface of a single closed crystal with a smooth surface.

The following four features must be considered in the design:

1.) Osmium parts of a jewelry piece must not touch each other in a way that allows their surfaces to grind against each other.

2.) If osmium designs contain “bridges”, these must not be too narrow to avoid bending.

3.) The design must be such that the osmium is protected by e.g. protrusions in the event of dropping the jewelry piece.

4.) Osmium carrier materials, such as the carbon sphere inside an osmium pearl, cannot and should not be removed.

Specific design guidelines for jewelry with settings

The manufacture of osmium jewelry necessitates meeting specific design requirements which depend on the chosen design. Osmium is often directly used as a cut shape without employing a second metal.

However, it is often important to use osmium in combination with other metals. The reasons for this include:

1. Jewelry becomes less expensive if some parts are made of gold or platinum, as they are about a twentieth of the osmium price.
2. The use of other metals prevents damage or improper handling of the osmium as per the Section “General design guidelines.”
3. The specific diffuse reflection effect, which is characteristic of osmium, can be created in certain parts of the jewelry piece by adding osmium.
4. If diamonds are not precious enough, osmium may be used to enhance jewelry further.
5. If care is taken to ensure that bridges in the material are always solid the durability of a jewelry piece will be increased.
6. If the structures to be created need two colors, metals can be used in combination.
7. Osmium can be used to create an effect of attracting attention with sublimity.

The following must be taken into account at the design stage if osmium is processed with a second metal:

- Osmium does not have to be cut into pieces to achieve the desired shape. Instead, unique shapes can be directly pre-ordered.
- Since manufacturing a shape requires setup works before the intricate cutting process, at least 20 to 50 pieces should be made for a new series.
- Certain shapes, such as a grain shape, a crescent or other typical inlay can also be manufactured in more significant quantities for use in different jewelry pieces.
- It should be noted that the layer thickness may vary by up to 0.3 mm if employment of an osmium piece with a single edge length of more than 20 mm is intended. The smaller the shape, the more even the layer thickness.
- If osmium is used in already manufactured jewelry series, geometries set with diamonds may be cut out and manufactured in osmium. The osmium piece can then be inserted without changing the manufacturing process or the design of the jewelry piece.
- Osmium cannot be bent and is not malleable. Therefore, the fit must either be perfect, have an overhang or the osmium is glued or soldered to a flat surface.
- Inlays can be manufactured to an accuracy of one-hundredth of a millimeter. Bridge widths should not be less than 1 - 2 mm.

If inlays or jewelry pieces require cannulation through the osmium for further inside cutting with the eroding wire, then the cannulation, the threading of the wire and the cutting need to be calculated separately. This will result in a fairly precise price calculation. Only the layer thickness cannot be calculated entirely in advance.

Designs need to be supplied as an electronic file and contain scaling information. On that basis, the cutting length and area can be calculated.

Pricing for osmium shapes can be obtained from the local Osmium-Institute which can calculate the price.

General care instructions

- Osmium is brittle and must not be dropped onto hard surfaces to avoid breaking.
- If osmium grinds against another surface or is bent, crystals may break out of the structure.

Protection against mechanical forces

Osmium is brittle. For this reason, osmium small curved bars, which some customers wear as rings, may break when dropped on hard surface. This event cannot be insured, as all documentation, including these Processing Guidelines and the Product Data Sheet, clearly state that small curved bars are of investment form only and not a finished jewelry product.

When osmium is to be worn as a ring, it is typically set into a concentric titanium sheath that protects the osmium in case the ring drops on a hard surface. Of course, other protective metals may also be used, but titanium with its slightly resilient material properties has proved to be particularly suitable.

In addition, the different colors of the two metals harmonize very well. In case osmium small curved bars are not intended to be kept as investment in a safe and worn as a jewelry instead, osmium small curved bars are supplied directly with titanium sheath.

Figure: Osmium small curved bar set in a titanium sheath to be worn as a ring

OSMIUM

Cleaning and storage of osmium pearls and other three-dimensional objects

Osmium pearls must not be rubbed between fingers or allowed to grind against each other, subjected to mechanical force such as stress, strain and shear forces, or forced into a product package.

The risk is not material abrasion, which is almost impossible, but breaking entire crystals out of the structure, affecting the surface in its perfection.

Further conditions that must be avoided when wearing osmium pearls include:

- Exposure to dust and grit
- Scratches
- Excessive strain on functional jewelry findings which may be transferred to the process-related hole or cannulation
- Rough mechanical stress
- Hooking crystals on clothes and breaking crystals out of the structure

Clean osmium pearls with warm water and/or substances which do not react with carbon.

Note: Once damaged, an osmium pearl cannot be repaired and loses its value completely.

Things you can do with osmium pearls, but not with natural pearls include:

- Exposure to perspiration and acids
- Exposure to make-up, ointments, perfume, hairspray, sunscreen, insect repellent, and talcum powder
- Exposure to soap and detergents
- Exposure to chlorinated water in shower or pool
- Storage in safety deposit boxes such as in bank vaults over a long period of time

Cleaning of osmium bars and other two-dimensional objects

Osmium can be cleaned with warm water, mild dish soap and a very soft brush. A professional pulsed-water cleaning appliance and a soft cloth may also be used.

Rinse osmium jewelry in a glass of water; pure osmium may also be swirled in acids.

Always be sure to clean and rinse osmium jewelry in a suitable container to avoid washing away small osmium pieces such as osmium diamonds or even an entire piece of jewelry.

OSMIUM

Safe storage of osmium jewelry

Proper storage of jewelry is often underestimated.

Any piece of jewelry, including osmium jewelry, should never be tossed into a drawer or on top of a dresser as there is a higher risk of scratches and damages.

In general, osmium should be stored separately in a way that prevents the osmium from grinding against other items and/or surfaces. Osmium jewelry pieces should be stored in suitable individual boxes or pouches to keep them safe from damage.

Jewelry boxes that feature individually padded slots for rings and posts for hanging necklaces and bracelets are also suitable.

Remember that for small osmium pieces the likelihood of confusing the osmium with other materials is great. Therefore, osmium should always be individually packed and be labelled with its Osmium Identification Code.

Note: If the allocation of osmium jewelry to the corresponding Osmium Identification Code can be ensured, the code may also be kept separately from the osmium jewelry during storage in the event of theft.

Customers shall be informed that individual osmium (jewelry) pieces should be stored separately in a way that prevents them from grinding against other items and/or surfaces.

It is also recommended that particularly intricate items should not be worn when doing manual works such as gardening, exercising or cleaning.

OSMIUM

Valuation, Certification and Identification

A jewelry evaluation is a document that describes a piece of jewelry or a semimanufactured product in detail and states its value. A jewelry evaluation is also known as a certificate.

Jewelry valuation is important for buying jewelry and for insurance purposes.

Osmium certificates are issued exclusively by the Osmium-Institutes worldwide and registered in the global osmium database.

Insurance

There are a variety of reasons why a customer demands a certificate when purchasing a piece of jewelry, but the most common reason is sale or exchange. Many certificates are issued for insurance companies.

According to their respective policy, most insurers would insure unspecified jewelry without proof of value just to a low value. If a claim is filed in case of loss, the insurance company will demand an invoice or a delivery docket as well as a proof of value.

The proof of value typically consists of the certificate, the invoice with a detailed description of the piece of jewelry and/or the delivery docket.

Osmium Identification Code

Obtaining an up to date valuation of an individual osmium piece (which may differ from the valuation of the osmium jewelry piece) is a straightforward process that only requires submitting the individual Osmium Identification Code on www.osmium-jewelry.com to get access to the certificate of authenticity including high-resolution photographs and to see the current price without spread for buying or selling.

It is possible for the owner or possessor of an osmium piece to register personal information (full name, country of residence, address, phone number) in the international osmium database by adding this information to the existing certificate. This should be ideally done at the time of purchase from private hands or directly with the jeweler.

Osmium can also be owned without registering personal information. In this case, evaluation is solely conducted based on the Osmium Identification Code.

Note: Valuation of an osmium piece can be solely based on the information recorded against a particular Osmium Identification Code and does not require any additional information, including personal information.