OSMIUM

Processing Guidelines

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Osmium Institute

Osmium Institutes Processing Guidelines

This document sets standards for working with crystalline osmium in the manufacture of finished products. It supports industrial processors and goldsmiths in technical matters of processing crystalline osmium in jewelry and related products.

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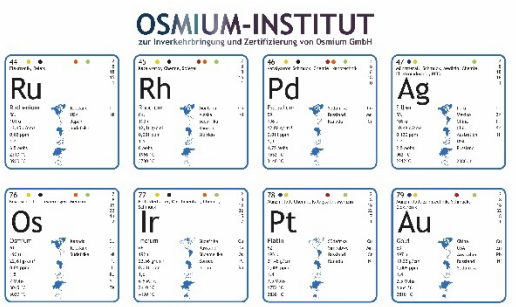
Basic Information

Osmium: The Precious Metal

There are eight precious metals:

Silver, Gold, Palladium, Platinum, Rhodium, Iridium, Ruthenium, and Osmium.



Osmium is the last of the precious metals to be introduced to the jewelry market.

The group of eight metals is called the Precious Metals group because these metals have the ability to resist chemical reactions such as corrosion and discoloration. Within the precious metals, osmium is assigned to the subgroup of the six Platinum Group Metals, since it has a great chemical similarity to platinum and is associated with it in nature.

Osmium is the densest precious metal in the world. At the lowest measured temperatures on earth, its density is a calculated 22.61 g/cm³. Crystalline osmium is produced from powdered osmium "sponge" in a crystal growth process. It is extremely resistant to chemical reactions and surface pressure.

Another of its notable properties is its abrasion resistance – the highest of all metals. As such, it is extremely resistant to mechanical impacts such as scratching or scuffing. Crystalline osmium has gained a lot of popularity since 2013, when the crystallization technique employed to create the flat, standardized form used in investment and jewelry production was discovered.

In its crystalline form osmium is chemically inert, non-toxic, and displays a decidedly elegant silver sparkle. More and more applications are emerging in the tangible asset, jewelry, and luxury markets. It has a very high melting point and in the crystalline form is available in flat two-dimensional shapes.

It is not sensitive to pressure, but rather to buckling!

Since its discovery in 1804, osmium has been used exclusively in very distinct applications because of its exceptional properties. The element with the atomic number 76 has the highest density of all non-radioactive substances and elements. In its crystalline form, it is characterized by its extreme abrasion resistance and reflectivity. The properties it develops during crystallization lead to osmium being called the uncounterfeitable element.

The Myth

Through a series of publications and the ingenuity of traders, customers, chemists and investors, many little stories and incidents have been created about osmium over the past decades. We would like to start this document with some of the facts and explanations to explain the myth around osmium and back it up with relevant facts.

As far as elements on the periodic table go, osmium was discovered quite late. It found its first applications as a filament in light bulbs, giving off a cozy warm-yellow light. However, it was too rare and expensive to continue to be used in the lighting industry. Today, this history can still be seen in the name of a major brand: OSRAM is made up of OSmium and wolfRAM, (German for *Tungsten)* the two elements that were first used in light bulbs along with tantalum.

In the myth of osmium traders, meanwhile, it won a number of epithets such as:

- The Sunshine Element
- The Next Generation Metal
- The Eternal Metal

The nickname "The Sunshine Element" is due to its blue-silver-white shimmer, which it already possesses under spotlight, but which intensifies massively when it enters sunlight.

Osmium reflects parallel sunlight in perfectly crystallized mirrors. The high light intensity can therefore be perceived from a considerable distance. This is in contrast to diamonds, which refract the light and thus

reduce its intensity. This effect is particularly visible when either the light source, the observer, or the osmium piece itself is moved: new patterns of reflective surfaces are consistently created on the osmium crystal.

This phenomenon creates what has been nick-named the "Osmium Sparkle", which is unparalleled in nature. At the same time, the surface of crystalline osmium, which is unique to each piece, makes it unforgeable, as it cannot be counterfeited.

The term Next Generation Metal aims at the fact that osmium is in the market for long holding periods and is bought to be passed on to a following generation. One waits in the investment market of osmium for what has been dubbed the “Osmium BigBang.” It refers to the

moment when crystalline osmium will have completely disappeared from the primary market and can only be bought from previous investors.

This effect is supported by the “Osmium ThinOut.” Crystalline osmium that has been incorporated into jewelry does not usually find its way back into the tangible asset market but remains in the jewelry. Thus, the available amount of crystalline osmium is continuously decreasing.

If crystalline osmium had to be recycled, the characteristic of the crystal structure would be lost, and the complex and cost-intensive process of high-grade purification and crystallization would start anew (which is the main part in the value chain.)

Every precious metal is an element, and thus indestructible. The meaning behind the title "The Eternal Precious Metal" is twofold: It comes from the fact that osmium initially became a part of the primordial Earth’s composition a very long time ago; and that osmium will never oxidize, erode, or tarnish.

Thus, crystalline osmium has become the absolute innovation in the jewelry market of our time. Innovations in the global jewelry industry have become rare.

The first osmium jewelry pieces on the market captivated with their elegance, while the silver-blue metal was already conquering the watch market. First movers were brands like Ulysse Nardin, Hublot and Czapek.

Image: Ulysse Nardin Executive Osmium Free Wheel

Unforgeability

Crystalline osmium is absolutely dimensionally stable and cannot be reversibly changed mechanically or chemically. This distinguishes it from the other precious metals. A significant advantage arising from this property is the fact that osmium cannot possibly be counterfeited.

Its crystalline surface, similar to a fingerprint, is recognizable with extreme certainty.

Explanation:

When a human fingerprint is scanned and recognized, their lines and ridges, or "*minutiae,"* are taken as a benchmark.

For osmium, by analogy, these minutiae are the microscopic edges of the crystalline structure. The microcrystals are inclined in three-dimensional space, meet at measurable angles within the metal ground plane at the crystal's base, and together create a recognizable face structure.

In addition, each crystal emerges from the material with a clearly identifiable length. Put simply, the crystals and at what angle they stand to each other make each piece of crystalline osmium absolutely unique.

Each piece is scanned at high resolution with Keyence microscopes at the German Osmium Institute and stored as a record in the international Osmium World Database.

Already on an area of one mm^2, the recognition reliability compared to a fingerprint is already over 10,000 in favor of the crystalline surface

of osmium. This number cannot be calculated with exactitude because within the crystalline structure of osmium in case of doubt always smaller structures could be considered.

When gold is counterfeited, it is often done with inserted or coated refractory metals of similar density as the core metal of a structure. Since much counterfeit material of this type is “blistered” or delivered with certificates, the slight differences in density are not noticeable and are only discovered during further processing. Therefore, such alloy counterfeit can be committed on a large scale.

For osmium, only one metal can be found with a density just below that of osmium.

This metal is iridium. Iridium cannot be coated with a crystalline face of osmium. In addition, crystalline osmium is delivered in very thin structures as flat ingots, so a true "interior" that could be filled with another metal does not exist.

Crystallizations of other precious metals differ significantly from osmium in crystal structure, so that they can be seen with the naked eye.

Purity and chemical resistance

Refined osmium sponge is delivered with a purity of 99.99%. In the process of crystallization, the purity increases again extremely, so that the final result after several purification cycles is at 99.999995% up to 99.9999999%. Thus, a 7N5 to 9N purity is assumed to be required to achieve a perfect and flat crystallization result.

Crystalline osmium is absolutely insensitive to corrosion and discoloration. Such effects cannot be caused by conventional and oxidizing acids. Typical acids are hydrochloric acid, sulfuric acid, nitric acid, phosphoric acid. The laboratory tests were carried out with concentrated acids and dilute acids with increased hydrogen ion activity and very low pH values.

Determination and digestion of osmium

"Sample Digestion" is a process of inorganic chemical analysis in which poorly soluble substances, very often oxides, silicates, or sulfates, are converted into an acid-soluble or water-soluble compound with the aid of digestion agents.

Possible detection of osmium can be done with osmium tetroxide. The process is simple, but not recommended. Given the toxicity of osmium tetroxide, detection would be made via the characteristic odor of the osmium tetroxide rather than a more precise measurement.

Chemical detection is, however, also possible. For this, a sample containing osmium would be combined with benzidine or potassium ferricyanide solution on filter paper. With benzidine, the paper turns violet in the presence of osmium tetroxide; with potassium ferricyanide light green. In modern analysis, these detections are no longer important; today, osmium can not only be detected but quantitatively determined with high accuracy using instrumental methods such as neutron activation analysis, voltammetry, atomic spectrometry or

mass spectrometry. NMR spectroscopy and X-ray diffraction enable the structural analysis of organic and inorganic osmium compounds.

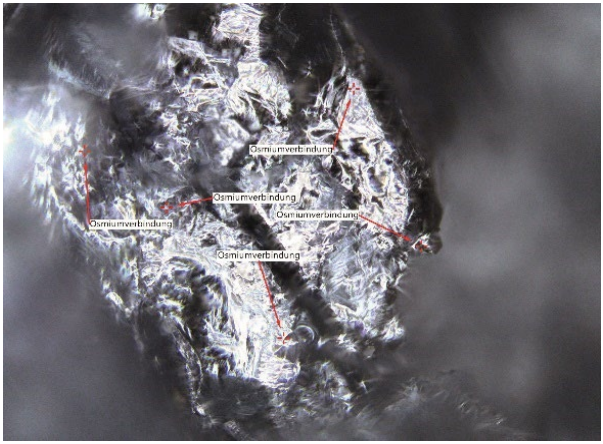


Figure: Analysis result on EA300

When determining osmium on the basis of the electronic methods, the settings and calibration of the used devices. Instrument manufacturers must be set on the basis of a real osmium sample, otherwise false readings may result, showing iridium instead of osmium on the instruments. The LIBS method is used in the laboratories of the osmium institutes.

Laser Induced Breakdown Spectroscopy - LIBS

Laser induced plasma spectroscopy

A laser pulse with a length of one nanosecond generates a short-lived and focused high-energy plasma burst at a defined location on the sample. The burst has a radius of 0.005 mm due to its extreme energy density. The plasma is formed from the surface material, which is deposited in a narrow area and emits light.

(The procedure is much more accurate and faster than the classical methods of X-ray fluorescence analysis. Neither radiation protection, a radiation protection officer, nor complex preparation of the sample is necessary for measurement).

The emitted light is split into its different wavelengths using a spectrometer. The light intensity of the different wavelengths is recorded in the detector and electronically processed. The sum of all spectra of the atoms contained in the sample is plotted in a wavelength diagram.

The characteristic spectra are selected and quantified. A percentage of each element contained is calculated from the total sample.

The resulting information is a qualitative and quantitative analysis of the sample's contained elements at the point of measurement. If one element is to be measured specifically, only the wavelengths of this element are considered in the measurement.

It is also possible to exclude elements from the measurement to disregard their content in the analysis.

A special variant of quantitative determination is the analysis of compositions at different depths below a surface. For this purpose, the laser penetrates the material several times in short pulses. In this way, up to 15 times the depth of a simple measurement can be achieved. In each of the 15 depth points, the selected analytical variant is performed qualitatively or quantitatively.

Fine osmium in crystalline form has a purity of 24 carats in the carat system. There are no alloys that are or can be used in crystallization.

Even the slightest impurities prevent crystallization.

Osmium alloys, however, are used in vanishingly small quantities in some areas of industry, regardless of crystallization. Osmium's use in biochemistry could become interesting in the next few years.

In summary, crystalline osmium never changes color or crystal structure, even when stored under adverse conditions or when storage must span a long period of time.

Crystalline osmium is inert at temperatures below 400 °C and therefore absolutely safe to handle.

Osmium Diamonds is the market designation for round structures from 2 to 9mm in diameter under the U.S. rulings jointly agreed with the Osmium Institutes and the U.S. Government.

Because of the name and low total weights, they are also measured in carats as well as grams. Osmium diamonds are already replacing low-value diamonds in jewelry production in many places.

Determination of osmium samples in the non-wet-chemical range

X-ray fluorescence (XRF) is the emission of characteristic secondary (or fluorescent) X-rays from a material that has been excited with high-energy radiation. The phenomenon is used in X-ray fluorescence analysis to determine the elemental composition of metals, glasses, ceramics and other materials.

If materials are exposed to irradiation by short-wave X-rays, the components are ionized by the ejection of one or more electrons. 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, emitting radiation characteristic of the element.

A corresponding sample was performed with the crystalline osmium certified in the German Osmium Institute. You can see the result on the next page.

Extract of the chemical analysis

EAG LABORATORIES

GDMS ANALYTICAL REPORT

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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)

C.BAZILLE (Analyst)

ISO 9001:2008 registered

Approved by: _____

The German Osmium Institute

OSMIUM-INSTITUT
zur Inverkehrbringung und Zertifizierung von Osmium GmbH

Osmium is crystallized in only one certified refinery in Geneva, Switzerland. The process and laboratory conditions are subject to secrecy and are under special security measures regarding laboratory safety, transport and anti-theft measures. Access for third parties is not allowed. Visits are excluded.

Certification and quality assurance are regulated by a contract between the Swiss crystallization laboratory and the German Osmium Institute for an indefinite period of time and are subject to strict mutual controls according to the dual control principle at every stage of production and certification.

Certification is tied to the automatic backup of all 3D and surface 2D HDR scans in the international world database accessible to international customs.

Quality assurance essentially comprises the following steps in the materials testing laboratory of the Osmium-Analysis Department:

- Examination for chemical purity using the LIBS method.
- Examination for nanoholes
- Examination for surface spikes
- Assignment of a sparkle degree between 1 and 5 in integer intervals, ordered by crystal size.

In addition, observed are: Decreasing layer thicknesses, edge artifacts, net regions, porosities, risks on buckling, breakdown, bending and similar mechanical action options.

Tested, registered, certified and registered in the world database crystalline osmium is introduced to the market internationally by the osmium institutes. Contact persons are available internationally in 40 countries for advice in the local language.

In the interaction between research, marketing and sales, more than 1,000 trained contacts are available internationally to advise and support customers, manufacturers, manufactures, jewelers, goldsmiths, family offices and governments.

Professional processing of crystalline osmium

Osmium soldering and processing under the influence of heat

When exposed to heat, crude osmium forms the compound Osmium Tetraoxide (also commonly referred to as osmium tetroxide.)

For crude osmium, oxidation is already observed at room temperature. It is immediately noticeable by a garlic-like odor even at the lowest concentrations in the parts-per-million range.

The threshold of perception seems to be below the limit of toxicity. Experiments on this segment of the research are not available. However, several scientists came into contact with osmium tetroxide in the course of their work.

The contact has caused discomfort in the eyes and respiratory system, which, however, subsided after a few days. Historical documents, current observations and own experience in handling the material confirm these observations.

In the case of crystalline osmium, the process of oxidation takes place only at temperatures far above 400°C under the influence of an overflow of oxygen-containing gaseous media. The process is still extraordinarily slow even at these temperatures.

$Os + 2O_2 \rightarrow OsO_4$

Therefore, osmium, which accepts the solder very well, can be safely soldered below 400°C. [1]

It is mandatory to use a measuring soldering iron that measures and displays the temperature of the soldering tip. On large workpieces with several square millimeters of surface area, the amount of heat supplied by soldering is dissipated as in any metallic material. On small workpieces, heat buildup can occur and should be avoided.

Up to temperatures of 450 °C, osmium has been brazed in experiments and in production processes without forming osmium tetroxide. Nevertheless, it is recommended to work with good ventilation or under a fume hood to eliminate any residual risk.

When exposed to higher temperatures above 500 °C, osmium slowly transforms into the oxide. The melting point was therefore determined in a vacuum, since it is practically not reached when osmium is melted under the action of oxygen from the atmosphere.

In principle, the crystallization of osmium can be thought of as similar to the crystallization of carbon into diamonds in the manufacturing process of artificial diamonds. With both osmium and carbon, crystallization transforms a dark powder into a different physical form with altered properties.

[1] Upon official request, *Osmium-Institut zur Inverkehrbringung und Zertifizierung von Osmium GmbH* can make available the results of the commissioned tests, which show the oxidation behavior as a function of temperature and the oxygen content of the atmosphere.

The name “Diamond” goes back to the Greek word *adámas* and means something like "*the indomitable*". Nevertheless, fire turns the "indomitable" into a gas. The king of gemstones burns to carbon dioxide at a temperature of 850°C and above.

Like graphite, diamonds consist of pure carbon and are therefore combustible. Unlike diamonds, osmium cannot burn as long as it is not present as finely divided metal dust.

It is interesting to know that nowadays about 40 tons of diamonds are produced artificially every year, which is about 330 times more than osmium crystallization. The tendency here is increasing. Since carbon is one of the most abundant elements on our planet, diamonds will never run out. This is where osmium scores with its rarity and security.

If the oxide forms due to high temperatures and the presence of oxygen, it will emit a distinct and pungent odor.

Inhaling lethal concentrations of osmium tetraoxide is impossible if the internal nose and olfactory mucosa are fully functional.

Experienced goldsmiths have successfully performed laser spot welding on osmium with proper safety precautions. If attempting this, it is important to take respiratory precautions or work under a fume hood.

The Osmium Institute strongly advises against heating osmium above 400 °C. If this does occur and oxide is produced, work should be immediately halted, and the area should be ventilated and evacuated.

Working with a gas mask and under constant eye protection is possible, but usually not necessary. Osmium tetroxide is an extremely volatile substance and does not remain as a substrate or sublimate on plant and equipment. Therefore, a half-hour ventilation of the room is usually more than sufficient.

Cutting with wire erosion

Osmium is cut into tangible asset shapes like ingots and discs using a cost-effective laser method. For smaller and more precise shapes intended for direct processing, a technique called wire EDM is employed.

Although theoretically possible, water jet cutting results in rough and imprecise edges. Therefore, this method is only suitable for roughly shaping ingots or removing overcuts in crystal growth.

While water jet cutting is significantly faster, its lack of precision makes it unsuitable for osmium cutting.

The wire EDM process has emerged as the preferred method due to its high precision, achieving accuracy within a few microns. However, it is a labor-intensive and expensive process. Nevertheless, alternatives are limited since osmium possesses the highest abrasion resistance among all materials, making it difficult to machine.

The remarkable precision of osmium cutting can be observed in the creation of microstructures. These structures are so delicate that deviations from the intended cutting geometry can only be discerned within the range of a thousandth of a millimeter. This process unlocks a multitude of new possibilities in jewelry design.

For wire EDM, as with any automated cutting process, the cutting track must first be defined and programmed in the CAD system. The aim is to arrange structures in such a way that only the smallest amounts of crystalline osmium have to be returned to the recycling process as offcuts.

Offcut remains between the shapes that are cut. It has approximately the value of raw osmium when returned to recycling. It is therefore quenched and tempered with the crude osmium price and crushed, burned, reduced to the metal, cleaned again several times and crystallized again several times until it can be reused.

Loss is also generated during the cutting process. Loss is the amount of osmium that remains on the copper, brass or molybdenum wire in the cut and cannot be recovered.

The ideal shapes for osmium cutting are osmium diamonds and osmium stars, each serving as the geometric counter-shape to the other. Apart from the minimal loss incurred during the wire erosion process, no other material is wasted.

To remove residues from the EDM wire, a ten percent hydrochloric acid solution is used, which is approximately equivalent to the concentration of stomach acid.

It is advised that the processing industry refrains from cutting osmium using diamond cutters or similar tools. Although it is possible to cut osmium with these tools, the resulting edges are rough due to the breaking of individual crystals within the structure.

The wire erosion nose refers to the entry and exit points of the wire during the erosion cutting process. In many cases, the nose is intentionally left intact to facilitate positioning of the pieces and simplify identification. It can be removed by using a diamond grinding wheel.

In general, if crystalline osmium undergoes external processing without certification, its intrinsic value diminishes. The new data would not be recorded in the Osmium World Database, rendering the piece unsaleable.

If cutting becomes unavoidable, it is strongly recommended to send the divided piece and the offcut to an institute for re-certification by referencing the original osmium identification code. Only trained and certified specialist companies should be entrusted with this process to prevent accidents or damage to the crystalline structure. A variety of semi-finished products and molds are readily accessible for use in the jewelry and luxury industry. These molds are available for purchase as long-term tangible assets or as semi-finished goods that can be directly incorporated into jewelry production. Therefore, it is

recommended to acquire pre-made semi-finished products, also known as "semi-manufactured goods," for convenience and efficiency.

The following should be known about the wire EDM process:

This section is translated from the Wikipedia article in German, "*Drahterodieren*". The download of the version took place on June 7, 2018.

Wire EDM, also known as wire cutting, wire erosion, spark erosive cutting or Schneider EDM, is a high-precision shaping manufacturing process for electrically conductive materials, which works according to the principle of spark erosion:

A sequence of electrical voltage pulses produces sparks that transfer material from the workpiece to a thin wire passing through it and into the separating medium, the dielectric.

The wire is then disposed of. The accuracy of the process is based on the fact that the spark always jumps at the point where the distance between the workpiece and the wire is minimal.

To achieve accuracies in the range of less than 2 µm, recutting is performed up to eight times, depending on the manufacturer.

Other EDM processes include die-sinking EDM and drilling EDM.

Brass is mostly used as the wire material. However, copper, tungsten and steel are also increasingly used. 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. EDM wires are available in the range of 0.02 mm to 0.33 mm due to the low tolerance (1 µm to 2 µm). Recent developments allow the use of two different wire diameters in one machining operation.

Wire erosion can be used to machine all conductive materials regardless of their hardness. This is in contrast to the long machining times and the associated high costs. However, extremely small cutting widths are possible even with large material thicknesses. The machined contours are sharp-edged and also meet

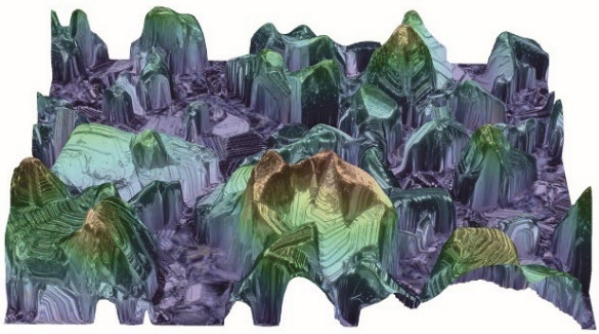
highest demands in terms of dimensional accuracy and shape precision.

Image: Wire cut by wire erosion process

Quality determination and pricing of osmium semi-finished and finished products

Every piece of crystalline osmium in the world database is guaranteed to possess impeccable purity and quality upon leaving the German Osmium Institute. This assurance is a result of stringent quality standards imposed by the jewelry and watchmaking industry, which necessitate thorough and precise inspections. These inspections commence with a visual examination and progress to the analysis of the osmium using high-resolution microscopes.

Osmium semi-finished products that exhibit surface spikes (prominent crystal outgrowths) or nanoholes (extremely small holes) undergo recycling. This recycling process is initiated during the initial step of opening the furnaces and removing the crystallized discs.



When discussing crystalline osmium production, the "harvest rate" refers to the ratio of osmium of satisfactory quality to that of unsatisfactory quality. This ratio plays a significant role in influencing the price of osmium.

Following that, the next crucial step involves determining the most suitable application for the crystallized disks. The finished semi-finished products are then categorized for either cutting into other semi-finished products or for use as inlays.

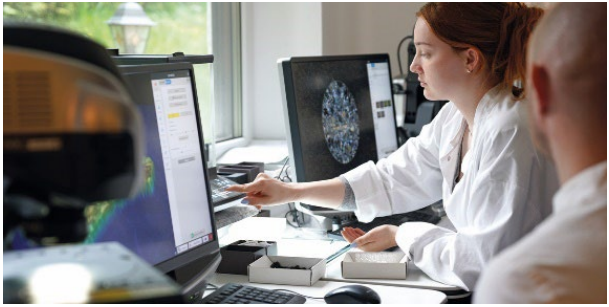
Use follows form. Form follows quality.

Further quality checks are performed as part of the certification process using Keyence high-performance microscopes, which provide surface scans as 2D HDR and as 3D false-color height profiles.

The test is performed technically, its evaluation is ensured by the laboratory staff of the Osmium Institutes.

In the process, each individual piece is subjected to different checks by several employees. This work can be viewed live in the glass laboratory in Murnau am Staffelsee as of spring 2024.

Certified pieces are released for assigned use in the Osmium World Database. A final visual inspection is also carried out shortly before delivery to rule out breakage, damage to shape or surface, and buckling.



Picture: Employees of the Osmium Institute in the certification process

Each osmium semifinished product is always qualitatively and quantitatively described with its unique characteristics to be identified based on the stored analyses and reports.

Determining the value of osmium pieces is simplified because, unlike carbon diamonds, they do not have to be polished and can usually be supplied ready-to-install.

The price corresponds to the production price, which is disseminated via a provision server in Switzerland. It refers to grams or carats depending on the piece and is recalculated and disseminated daily. It does not represent a rate.

Even if the quality is always identical, crystalline osmium also has different pricing, which is caused by the shaping, i.e., the cut, as well as the mass. This will be discussed in more detail below.

1) The different mass:

Crystalline osmium is priced by weight, normally by gram. The daily price per gram, which depends on the harvest rate, can be found at www.osmium-preis.com.

The price of crystalline osmium increases with the area and the crystallized layer thickness, which together make up the volume of a piece. The density thus determines the mass, which, expressed in grams in relation to the price per gram, dictates the price of a piece.

Put simply:

Crystalline osmium in the form of bars, discs and squares is always sold by the gram. No matter what size, layer thickness or crystallization it has. Quantity discounts cannot be granted, as larger production quantities do not simplify or cheapen the process.

2) The different shape:

There are four price levels of osmium forms, which will be briefly explained here:

A) *Shapes without extra charge: discs, bars and squares*

These pieces can be cut easily and approximately without loss or great mechanical effort. Since they are usually also larger pieces, the certification and packaging effort is only of minor importance here.

These pieces are each calculated according to the current price per gram and are particularly suitable as an investment in kind in crystalline osmium. They are not yet subject to any destination and can be purchased regardless of taste and fashion.

B) *Shapes that have a small surcharge: Diamonds, Stars, Triangles*

These pieces each have a perfect counter-shape, and there is hardly any offcut when cut. One osmium diamond and one osmium star each are the exact geometric counter-shape to each other, so there is hardly any offcut and loss when cut. Osmium triangles form the opposite shape to themselves.

C) *Shapes with comparatively higher surcharge: standard shapes that differ from the already mentioned shapes, but are produced in larger quantities (e.g., hearts, letters, shooting stars, unicorns, elephants, lizards, etc.)*

These pieces are often requested and are included in the standard assortment of osmium institutes, thus eliminating some costs described in more detail in Category D.

When these shapes are cut, however, a significant amount of crystalline osmium becomes offcut. This quantity is priced in. Thus, these pieces are only of interest to collectors and not as a tangible asset. For some jewelry and luxury applications they are in high demand and customers here accept the premium to the price per gram because they get a defined shape is already obtained in the precut.

D) *Shapes with high surcharge: one-off production that deviates from standard shapes. (e.g., logos, new productions, special designs).*

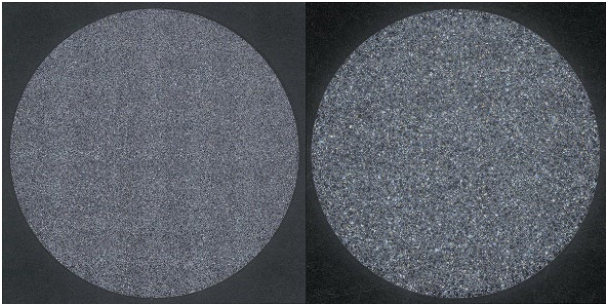
All requested custom shapes are first checked for the general possibility of production. This includes, above all, the web widths and breakthrough dimensions to be complied with. Once a quotation has been received, CAD files are produced, machines must be set up, a suitable disc for the selected shape is determined, new fields and categories must be entered into the Osmium World database, and a significant amount of offcut is usually produced. Dials for watches also fall into this category.

All forms of category D are not offered by the Osmium Institutes, but by Oslery GmbH on a contractual basis, produced and recorded in the world database in cooperation with the Institutes.

3) The different Sparkle:

Different batches of osmium produce different crystal structures on the surface of the osmium, which are a direct function of the layer thickness and thus the crystallization time.

The longer an osmium disk has undergone crystallization, the thicker it becomes in crystal growth.



Disks crystallized between 0.4mm and 1.2mm layer thickness and are classified in sparkle level 1 (very thin) to sparkle level 5 (very strong).

In this case, the individual crystals of the thin pieces are much smaller than those of the pieces with greater layer thickness. No surface with low layer thickness but high sparkle degree can be created.

With the increased layer thickness, the stability against mechanical influences such as buckling, bending or cracking also increases. Since each crystal reflects light back into the viewer's eye like a small mirror, the larger crystals sparkle optically more intensely and with "larger flashes of light," while the smaller ones sparkle more evenly but not as intensely.

This can be seen particularly well at some distance from the osmium workpiece in parallel sunlight. High sparkles can be seen with the naked eye at a distance of up to 35 meters due to the perfect reflection of the perfectly grown crystalline micromirrors in contrast to the refractive diamond.

Sparkle grades are therefore crucial for different uses. Letters, small objects, most watch dials, or even many inlays for “feminine-looking” jewelry are cut from low sparkle. Pieces for distance viewing, which are intended to catch the eye even at a great distance, should rather have a high sparkle grade.

So, there is no "better or worse" here, but simply a correct choice of sparkle grade for the desired end product.

However, crystalline osmium is priced according to mass, i.e., weight, in the first step. The heavier a piece of crystalline osmium is within its higher layer thickness, the more it costs. The surcharge includes cutting costs and design costs.

Osmium Pearls and Osmium Round Bars

Since Osmium Pearls were discussed in the previous version of the Processing Guidelines, we want to mention them along with Osmium Round Bars ("Osmium Rings"). Osmium Pearls were a project that the Swiss crystallization company approached in 2018. Osmium was crystallized as a thin layer on a carbon body, which then resulted in a sphere, that is, a sphere with osmium coating.

Despite extensive research, production unfortunately had to be postponed because the harvest rates were too low.

A new market launch is currently expected in 2028.

The identical phenomenon was seen in osmium round bars, often popularly titled "osmium rings."

They also proved to be still uneconomical, since here, too, only a small quantity of material of sufficient quality could be obtained. In addition, the structures proved not to be crack-resistant when subjected to tensile forces and impact on hard substrates.

Currently, osmium is produced and certified for use in manufactories flat crystallized.

Processing methods of conventional jewelry production with osmium

Setting Osmium: The easiest ways to connect osmium to jewelry are setting or gluing osmium 2D objects to any surface. Another method is welding or soldering. Regardless of the approach, the "fit" of the inlay must be very level and as little lateral pressure as possible should be applied to the osmium inlay with the risk of buckling.

- Setting: Setting osmium 2D objects is much easier than with conventional brilliant-cut diamonds, which have a pyramidal or conical shape after the rough diamond has been cut. Osmium, on the other hand, is always flat, and therefore very easy to set. It lends itself to both a classic bezel setting and a madder setting.

- Adhesives: There are various adhesives that can be used to successfully incorporate osmium into jewelry. Normal jewelry and multi-component adhesives are the adhesives of choice here. Reactions with adhesives that affect osmium are not known. Gluing flat structures with low sparkle can cause the inlays to break when they are removed.

- Soldering/welding: Soldering or laser spot welding are also possible. With these processes, the temperature must be keenly observed. The protective measures mentioned above must be observed.

  Note: Solder can be chemically removed from the osmium surface. It is most easily dissolved in an acidic environment that does not damage the osmium.

Machining Methods: Osmium is brittle and CANNOT be bent like gold or silver. Osmium inlays with low sparkle should therefore be handled with special care as long as they are not embedded in a protective material. They must be installed on a flat surface.

Figure: Crystalline osmium is formed exclusively by cutting according to shape instructions.

For this reason, it is purchased in finished form or ordered as an inlay in the desired shape. The order of special shapes is handled by Oslery GmbH.

Crystalline osmium is not cut by the processing industries but is purchased as a finished inlay. In exceptional cases of high production volumes outside Europe, cutting companies are trained and certified.

In this case, it is mandatory that the cut pieces be certified by the local Osmium Institute BEFORE the inlay is placed in the jewelry.

In case of a reversal of the order, weighing and dimensional determination are no longer possible. The certificate in the Osmium World Database would become invalid and could not be reissued without removing the inlay again.

Sawing or filing is possible, but not recommended, due to its high abrasion resistance and possible breakout of crystals.

In these processes, the surfaces of the material are not changed, but entire crystals are torn from the surface. In this case, too, the certificate loses its validity.

Exception: The alignment nose is removed but the piece retains its shape.

ATTENTION:

It is strictly prohibited to anneal osmium. The reason is that at the extremely high temperatures involved in annealing, osmium tetroxide will inevitably form in significant concentrations. Additionally, annealing cannot achieve thermal hardening of the material, and the process is not feasible due to the absence of required additives. Furthermore, annealing is unnecessary for osmium.

By contrast, osmium can certainly be ground to remove the positioning nose on osmium diamonds. Please note that the cut will always be very coarse, as osmium can only be rubbed off poorly. Small and tiny crystals will tear out of the structure. The human eye has too low a resolution to detect the machining, but it will be visible under the microscope.

In general, a distinction must be made between whether osmium is abraded or whether crystals are torn out of a surface. In this context, processing with a diamond file should be mentioned, which also does not classically process the surface of osmium, but also breaks micro-crystals from the structure. This appears like the process of filing, where chips are separated. These chips do not occur with osmium because crystalline osmium is more abrasion resistant and dimensionally stable.

If grinding is used, diamond grinding wheels must be used. Emerizing and polishing are processes that are not and cannot be applied to osmium, as in each case the existing crystal structures have perfect luster and smoothness. Attempting to emery would break out crystal pieces and perhaps even destroy the entire piece of jewelry.

Osmium must not be rhodium-plated under any circumstances, because this leaves a milky white hue that cannot be removed. Crystalline osmium cannot be completely protected even by covering it during rhodium plating. Therefore, if rhodium plating of the substrate is desired, it must be performed BEFORE inserting the osmium inlays.

Caution: When fitting crystalline osmium, care must be taken to avoid buckling, i.e., the application of force with force fluxes within and parallel to the crystallization plane. Crystalline osmium usually fractures and buckles when such force action is directed with a normal force from below on the surface.

Cleaning and maintenance of osmium

As the noblest of the precious metals, osmium is very easy to use in everyday life. It can easily withstand water, sweat, soap or even disinfectants.

Also, due to the carrier media used, the material is particularly stable in its bound or glued form and therefore almost impossible to damage in its installed form by normal manual forces.

A generally cautious approach is recommended, as one would with other precious jewelry. However, unlike other metals, osmium cannot scratch or wear away.

Crystalline osmium has a rough surface that is naturally enchanting, but also ensures that skin debris, clothing fibers, or other contaminants could get caught on it.

The cleaning of osmium is very simple. Since the material is more noble than gold, acids can also be used for cleaning, provided they do not impair or dissolve the substrate materials.

An ultrasonic bath or cleaning with a gentle toothbrush, water and a commercial soap is usually sufficient.

General design guidelines

Since osmium can be damaged by incorrect handling, this fact must already be taken into account in the design of jewelry. The property of breaking out large crystals is independent of the extreme abrasion resistance that osmium possesses. The abrasion resistance refers to the surface of a single closed crystal with a smooth surface.

Six features must be considered in the design:

1.) Osmium inlays of the jewelry should not contact each other such that their surfaces rub against each other.

2) Osmium inlays must not be so narrow that they could bend. In general, the basic rule is not to go below 1.5mm bar width.

3) The design of a piece should allow for the osmium to be properly protected should the jewelry piece fall.

4) The carrier materials must not be removed, as osmium is generally used as an inlay.

5.) Osmium must always be used in flat form without bending or kinking.

6) Attention must be paid to the protective measures in case of high heat exposure during processing.

Specific guidelines on the design for jewelry with inlays:

Making jewelry with osmium requires meeting some requirements for the design that is chosen. When osmium is processed with a second metal, the following must be observed in the design:

- Osmium does not have to be pieced in order to reproduce a flat shape, but the special shape of the inlay can be pre-ordered directly (see cooperation Oslery GmbH)

- Since special shapes are prepared in a complex way, series of at least 20 to 50 pieces should be produced for industrial applications.

- Certain shapes, such as a drop, a crescent or other typical inlays, can also be produced in advance in larger quantities to be used in different pieces of jewelry.

- If osmium is to be processed in a surface with a single edge length of more than 20 mm, then it should be noted that the layer thickness can vary by up to 0.3 mm. The smaller the shape, the more uniform the layer thickness within the piece to be used.

- If osmium is to be used in jewelry series that have already been successfully produced, then the shapes set with diamonds or other gemstones can simply be replaced with osmium. This allows the entire surface of crystalline osmium, unlike a *pavé* for example, to be used without altering the jewelry in production or design.

- Osmium cannot be bent or ductile formed, so the fit must either be perfect, have an overhang, or the osmium is bonded to a flat surface, laser spot welded, or soldered.

- The pre-production of inlays can be carried out to the hundredth of a millimeter. Again, bar widths should not be much less than 1.5 mm.

- The construction of three-dimensional structures is possible when small objects are applied to the structure in planar shoring. Many small pieces then create a 3D structure together.

If inlay work in jewelry pieces requires drilling in the crystalline osmium, the cutout is created using the EDM process. Threading of the EDM wire for the cutout and cutting of the area are priced exactly in advance.

The coating thickness alone cannot be calculated 100 percent in advance, but it can be estimated well (a sparkle grade may be desired in advance).

All files are to be supplied as outlines and must include at least one size dimension so that cut length and area can be calculated.

To calculate prices for osmium molds, osmium institutes and uses Oslery GmbH international a spreadsheet, which calculates the impact of delivery times and quantities in addition to the cost of the work.

General precautions

- Crystalline osmium is brittle may break if dropped on a hard surface

- When crystalline osmium is rubbed or bent against another surface, micro crystals can break out of the structure.

Protection against mechanical influences

Osmium is brittle. For this reason, osmium round bars in particular, which are sometimes worn by customers as tubing, can break if dropped on a hard surface.

Such a fall is not insurable, as the documents on crystalline osmium each state that it is a shaping as a tangible asset in the form of a ring, called a round bar, and not a piece of jewelry to be worn.

If an osmium round bar is still to be worn as a ring, it is worn in a titanium encasement that protects the osmium in the event of a fall.

Other protective metals can be used, of course, but titanium, with its resilient properties, has proven particularly useful.

In addition, the colors of the two metals harmonize very pleasantly. Osmium rings were usually delivered directly with the titanium coating during production, if they are not stored in a safe as a round bar for purely tangible investment.

Round bars are no longer produced and are listed here only for the sake of completeness.

Pictured above: Osmium round bar in a titanium protective coating

Substances, influences, and storage conditions that affect or chemically alter some metals but have no effect on crystalline osmium:

- Sweat and acids
- Make-up, skin creams, perfume, hair spray
- Sunscreen, insect repellent
- Talcum powder
- Soap and detergent
- Chlorinated water in the shower or swimming pool
- Storage in safe deposit boxes in banks for long periods of time
- Outdoor storage in the open air

Evaluation, Certification, and Identification

A jeweler's certificate of authenticity is a document that describes a piece of jewelry or a semi-finished product in detail and declares its value in parallel.

These certificates are recommended or even necessary to purchase jewels and to insure them.

Osmium certificates are issued exclusively by the worldwide represented Osmium Institutes and their laboratories and are registered in the worldwide Osmium database.

This applies both to the certificates of the individual osmium inlays and to the higher-level X-code certificates for jewelry with multiple osmium inlays (see X-code explanation below).

Expert opinions on crystalline osmium can be requested from the Department of Analysis in Osmium Institutes.

Insurances

There are a variety of reasons why a customer may request a certificate when purchasing a piece of jewelry, but the most common reason is to sell or exchange. Many certificates are created for insurance purposes.

Most insurers, depending on their policies, will only insure unspecified jewelry delivered without proof of value up to a low value. If there is a loss and a claim is filed, then the insurance company will pay the bill.

The proof of value consists of the certificate of the X-code, the purchase invoice with a detailed description of the jewelry and the delivery bill. In the best case, pictures of the entire piece of jewelry also exist.

Osmium Identification Code

Each piece of crystalline osmium is assigned an *Osmium Identification Code* (OIC for short) during certification at the German Osmium Institute. This allows direct access to the information of the piece (weight, dimensions, net new price and high-resolution scans for recognition).

Code by alphanumeric representation and as QR code

When an osmium piece is purchased, an Owner Change Code (OCC) is sent via email. Similar to a vehicle registration document, the OCC serves as proof of ownership and identifies the specific piece.

The OCC is used to retrieve a certificate with the owner's name, register the piece for sale, or temporarily transfer ownership to another individual. Once the ownership is changed using the OCC, the previous OCC becomes invalid, and the new owner receives a new OCC via email. The new owner's information is then recorded in the Osmium World Database as the permanent owner.

It is advisable to register personal data (name, country of origin, address, telephone number) in the international Osmium database as the owner or holder. This registration is best done immediately when purchasing from a private individual or a jeweler, while adhering to the current data protection guidelines set by the Osmium Institute.

Additionally, arrangements for inheritance can be recorded in the database.

Osmium can also be owned anonymously; in which case its value relies solely on the Osmium Identification Code (OIC). However, in such cases, it is not possible to receive an OCC via email, which can make future sales or transfers more challenging. Most owners prefer to be registered in the database, which requires both the OIC and OCC.

Certification of the entire end product:

Each piece of crystalline osmium has an OIC and is stored in the Osmium World Database. When one or more pieces are incorporated into jewelry, they are normally removed from their packaging and therefore separated from their OIC.

There may be confusion between pieces and, in the worst case, recertification at the Osmium Institute may have to be requested for a fee.

However, since the osmium usually has to be removed from the jewelry first, this is an expensive and, in the best case, avoidable undertaking.

It makes sense to file the osmium as "processed" in the Osmium World Database and have it summarized into what is called an X-code. An X-code is a higher-level code that marks one or more pieces of osmium in the database as processed and then combines them into a single workpiece with a higher-level code.

As for the osmium inlays, photos of the final end product, dimensions, weight, price defined by the jeweler and other materials used, such as precious stones and precious metals, are recorded in the database. With the exception of the photos of the final end piece and the OICs used, the above parameters are to be provided on a voluntary basis. If desired, price or total weight do not have to be entered.

The advantage of an X-code is the mapping of the ownership of the crystalline osmium in the Osmium World database and the receipt of a certificate from the German Osmium Institute for the entire piece of jewelry and all materials used. Most customers want this explicitly for insurance purposes.

An X code can be requested from Oslery GmbH online at https://oslery.com/services/berechnung-x-code/, specifying the relevant data.

Most customers of jewelry containing crystalline osmium have extensively researched the material prior to purchase and request both the rewrite in the database based on the owner change code and the final certificate of the jewelry.

Value determination:

For crystalline osmium, the process of determining the current value is very simple, as the respective OIC only needs to be entered on the Internet at www.osmium-identification-code.com to see the current price without a spread for buying or selling.

This applies only to semi-finished osmium products, i.e., osmium that hasn't been set as an inlay. It is recommended to create an X-code and to determine an RCP and have it entered. In this case, after the inlays have been installed, all prices of the individual osmium inlays are no longer displayed, but only the final price of the jeweler is shown.

The price of a final end product with an X-code is always left to the manufacturer or jeweler. The price is optionally entered, or the jewelry has no online sales price with entry in the Osmium World Database.

The Osmium Gallery

Working with osmium is often a source of fascination and love for individuals, as this sparkling precious metal is beautiful, rare, and represents an absolute innovation. However, osmium remains relatively unknown in international markets. Therefore, in addition to personal marketing efforts, it is recommended to utilize the dissemination channels provided by osmium institutes.

To facilitate this, Oslery GmbH has created a platform that allows users to advertise jewelry artwork containing crystalline osmium. Currently, this service is offered free of charge and is available to any partner. It is important to note that all contributions and posted information are subject to verification, ensuring compliance with ESG-M guidelines to prevent usury or fraud, which benefits the entire market.

On the Osmium Gallery website, users can upload pictures, descriptions, and asking prices for various osmium pieces. It is essential to clarify that the website functions as a reference platform rather than an online store. Interested buyers can access the manufacturer's website directly from the platform to make a purchase.

The Osmium Gallery is recognized as a reputable website by over a thousand internationally based distributors who seek information on crystalline osmium and its applications. Therefore, it is highly recommended to establish a web presence on this platform. In the event that the service becomes chargeable in the future due to high demand, pieces already posted will remain on the platform free of

charge. As of now, the basic services provided by the Osmium Gallery are offered at no cost.

Work with Oslery GmbH:

Oslery GmbH was founded to satisfy special requests for special cuts and training requests in the manufacturer segment.

The company name is composed of OS-mium and jewel-LERY. Oslery GmbH is located in Munich and is the international contact point when information on the processing of crystalline osmium is required. Oslery GmbH offers the following services:

1) Training of processors and contact point for questions
2) Co-issuing and co-editing of processing guidelines
3) Creation of the X-code for finished end products
4) Fabrication and certification of special inlays
5) Support of the www.osmium-gallery.com

Special service for manufactures, manufacturers and goldsmiths:

Handling requests for crystalline osmium as commission material for processing tests and for the production of own first jewelry pieces in small series or as prototype for large series.

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