TESTING PRECIOUS METALS IN THE WORKSHOP

Here are some basic procedures experienced jewelers can use to test metal fineness easily and safely

by Alan Revere
photos by Barry Blau

Underkarated merchandise abounds in the industry today. Ethical jewelers need to know that the goods they're buying and selling really contain the metal fineness promised by their quality mark. That's why it's sometimes necessary to test a piece of jewelry or scrap metal in the course of operating a jewelry workshop. Jewelers around the world use the following traditional procedures to determine the quality of their products and raw materials, and to assign value when buying and selling antiques, used jewelry and scrap metal.

This article is an introduction to basic procedures which can be used easily and safely in a small jewelry workshop. Included is a sequence of steps for determining the composition of an unknown sample, beginning with visual and tactile inspection, and followed by a series of acid tests including the ancient touchstone test. With the correct equipment and with knowledge based on experience, a goldsmith or jeweler can quickly identify the primary metal in an unknown sample, the gold content (karat or fineness) for gold items and the silver content for silver items.

If precise scientific testing is required, samples should be submitted to a professional laboratory where gold items are tested by fire assaying (cupellation) and silver is subjected to titration.

A word of caution: The procedures for testing precious metals are not inherently dangerous, as they are used safely by thousands of jewelers every day. However, caution should be taken whenever handling acids, even in the very small quantities required for testing. Eye, face and hand protection is recommended, since direct contact can be dangerous. Fumes also should be avoided. Always keep a box of baking soda within easy reach so that an accidental spill can be neutralized immediately. The mixing of acids should be carried out only by experienced persons. Always add acid to water and not the reverse. If you have any doubts, get the help of an experienced professional.

Inspection: Before submitting an unknown sample to the acid test, you should collect important information by inspecting and handling the item. Examine the piece with a loupe. Feel it. Notice the finish, heft, color, stamping and general appearance, all of which can aid in identifying the metal. Consider these questions:

- Does the item have a quality mark? Quality marks *may* be an indication of the karat or fineness, although they should not be assumed to be correct.
- Is the item marked in the European system of 585 and 750, in the American system of 14k and 18k or in the English system of 9ct and 18ct? This observation may help to determine the origin of the piece.
- Is there a maker's mark or trademark next to the quality mark? Its presence often indicates that the quality marking is reliable. Again, however, nothing should be taken for granted.
- Does the metal look like gold? Gold has a characteristic color and appearance which an experienced eye can recognize. Plated brass and other surface treatments do not look quite the same.
- If the item has been worn, are there high points or corners which now reveal subsurface metal of a different color? If this is the case, then the item is most likely either

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1. Tools, supplies and solutions for testing precious metals.

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2. Nitric acid applied to 14k gold (right) shows no reaction. When applied to brass (left), the solution immediately turns green.

Table of testing solutions and reactions for various metals

Metal	Test solution	Reaction
Gold plated or gold filled over brass	Nitric acid	Surface—none Subsurface—green
Gold plated or gold filled over sterling	Nitric acid	Surface—none Subsurface—cloudy
Silver plated over brass	Nitric acid	Surface—cloudy Subsurface—green
Gold alloys above 18k (.750)	Aqua regia	Varying shades of brown; faster & darker reactions indicate lower fineness
Gold alloys: 14k (.585) to 20k (.833)	Weak aqua regia	Shades of brown
Gold alloys: 10k (.417) to 16k (.667)	Nitric acid	Shades of brown
Gold alloys below 10k (.417)	Weak nitric acid	Shades of brown
Fine silver (1.000)	Nitric acid Schwerter's	Light cloudy Bright red
Sterling silver (.925)	Nitric acid Schwerter's	Cloudy Dark red
Coin silver (.900)	Nitric acid Schwerter's	Brown-cloudy Reddish brown
Low silver (below .800)	Nitric acid Schwerter's	Turquoise Shades of brown
Platinum	Aqua regia	None
Palladium	Nitric acid	Brown
Brass	Nitric acid Schwerter's	Green Light turquoise
Copper	Nitric acid Schwerter's	Blue Dark turquoise
Nickel silver (contains no silver)	Nitric acid Schwerter's	Turquoise Blue at edges
Lead	Schwerter's	Yellow-brown

plated or filled, and not solid gold.

• If it is yellow, does the item have the heft of gold? Gold alloys of 14k and 18k are about twice as dense as brass and therefore feel much heavier by comparison.

• If it is white, does the item have the look and feel of platinum? Platinum is about 50% denser than white gold. In addition, platinum has a white color, compared to white gold's slightly yellowish tint (unless the white gold has been plated with rhodium, which gives it lustrous steely gray polish). By comparison, sterling silver is much lighter in weight than either gold or platinum, and is not as white as platinum. It is rare for an item marked platinum to be mismarked. However, don't assume a quality stamp to be accurate without testing. Common marks on platinum are "10% Irid. Plat." which indicates an alloy of 90% platinum and 10% iridium, or "5% Ru. Plat." which indicates an alloy of 95% platinum and 5% ruthenium.

3. A needle file has been used to make a very small nick on a hidden area of the chain in question.

4. A drop of nitric acid results in a bright green reaction, indicating that the subsurface metal is brass.

Qualitative and quantitative tests: After the item has been inspected for clues to its composition, two types of tests can be performed in order to determine the contents. One type is qualitative; here the goal is to determine the primary constituent of an unknown alloy. These tests are based on the fact that each alloy responds to specific acids in a characteristic way. For example, brass responds to nitric acid by turning the acid green.

After the primary constituent of an alloy is determined, the second type of tests can be performed. In quantitative tests, the purity or fineness (karat of gold) of the alloy is determined. The quantity of the predominant precious metal can be ascertained by comparing the reactions of various samples to the same acids.

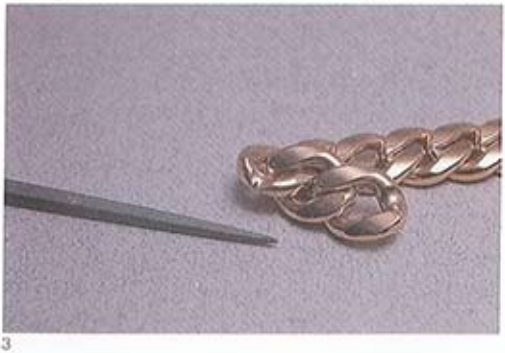
Quantitative testing of gold alloys is accomplished by using the touchstone test.

Equipment: The touchstone and other acid tests require tools and supplies which can be purchased through jewelry supply houses. Here is what you'll need (shown in Figure 1, from left in the front row).

Paper towel is used to soak up test-

5. Effects of Schwerter's solution (from left to right): on fine silver (1.000), bright red; on sterling silver (.925), dark red; on silver below .800, orange-brown.

6. Applying a drop of oil to the touchstone.



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ing acids from the touchstone in order to stop the process and make visual determination easier.

A specialized black *touchstone* is used to accept the rubbings of metals during testing.

• A set of *test needles* is required for gold testing. These are a series of brass rods with gold tips ranging in fineness and marked accordingly. Rubbings from these needles are the standards against which unknown gold alloys are compared.

A *plastic abrasive pad* is used with water to remove metal rubbings from the touchstone.

Always keep a box of *baking soda* (Figure 1, rear) within reach when working with acids. In the event of a spill, spread baking soda on the acid immediately to neutralize it.

A series of testing solutions also is required (Figure 1, middle row from left). These may be purchased in premixed vials from jewelry suppliers or made with the components listed, using the precautions mentioned earlier. Each testing solution is effective for a limited range of finenesses, being neither universal nor specific.

A drop of household or motor *oil*, rubbed into the stone, darkens it and facilitates visual comparison between the acid etched rubbings.

Weak nitric acid is used to test gold alloys below 10k. It is composed of 5 parts nitric acid added to 7 parts distilled water.

Concentrated *nitric acid* is used to test gold alloys between 10k and 16k.

Weak aqua regia is used to test gold between 14k and 20k. It is composed of 40 parts nitric acid, 1 part hydrochloric acid and 15 parts distilled water.

Schwerter's solution is used to test silver alloys, brass, nickel, lead, and copper. It is composed of 51 ml nitric acid, 53 ml distilled water and 5 g of potassium dichromate.

Aqua regia (royal water) is used to test platinum alloys as well as gold alloys above 18k. It is composed of 1 part nitric acid and 3 parts hydrochloric acid. This solution has a short shelf life and should be discarded after a few days. To discard a small amount of acid, pour it slowly down the side of a large bowl filled with a solution of water and baking soda. After all reaction has subsided, the acid solution may be considered neutralized.

7. Rubbing a ring of unknown metal on the touchstone, indicated by the letter "R."

8. Rubbing the stone with a 12k test needle.

9. Rubbing the stone with a 14k test needle.

10. A stripe of nitric acid is made across the three rubbings. The 12k rubbing turns brownish immediately.

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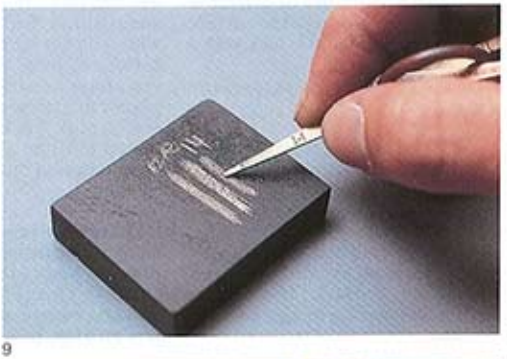

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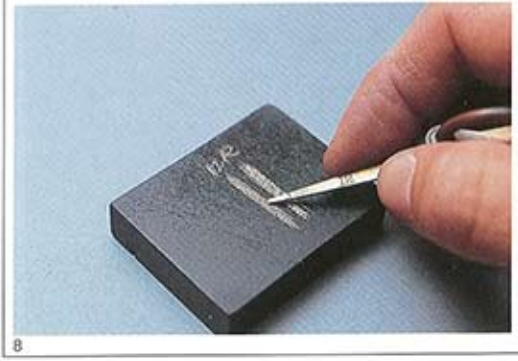

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Qualitative test for gold: A yellow metal should be tested to determine if it is gold, prior to determining the karat (fineness). Applying a drop of nitric acid to the surface of an item of gold will have little immediate reaction, depending on the karat. However, items which may be mistaken for gold, such as brass or bronze, will immediately turn nitric acid green (Figure 2).

After testing, use a pair of tweezers to bring the tested items to a sink and flush thoroughly in running water.

Qualitative test for gold and gold filled: If you suspect the sample to be tested has been lacquered, plated or gold filled (having a mechanically applied veneer of gold), you must scratch the surface to reveal the subsurface metal. Try to select an area where the nick will be unnoticeable, and where minimal damage will result.

1. Use a needle file or graver to make a scratch through the surface (Figure 3). Examine the nick with a loupe to determine if there is a visible difference in color. Such a difference would indicate a sample which is not solid gold.

2. Apply nitric acid to the nick. If the item is solid gold, there will be no immediate reaction. If the subsurface layer is brass or another nonprecious alloy, then it will react immediately by turning the solution to a different color (Figure 4).

Qualitative and quantitative tests for silver: A special solution called Schwerter's solution can be used to test alloys which may contain silver. The presence of silver as well as the approximate fineness may be determined by observing the reactions. Applying a drop of Schwerter's solution will reveal the presence of at least 50% silver by turning the metal a range of colors. The brighter the red color of the reaction, the finer the silver alloy (Figure 5). Comparative rubbing on the touchstone also will indicate the relative fineness of silver alloys. Rubbings from alloys with a higher silver content will feel softer and look whiter in color. Silver alloys are frequently rhodium plated to increase hardness and resist tarnish. These items cannot be tested until an area of plating has been removed by filing, engraving or sanding.

Quantitative test for gold alloys using a touchstone: The touchstone test has been in use since at least 600 B.C. This ancient method finds universal usage even today because it is an easy, convenient, quick and relatively accurate way to determine the fineness of gold alloys. Touchstone testing requires a few basic supplies, and can be used on items of any size with only a minor loss of material. An experienced tester can confidently determine the fineness of gold alloys within one karat or even less.

The method works because precious metals are very resistant to acids. That means alloys with a high percentage of precious metal are more resistant than alloys with a lower precious metal content. In other words, when tested with the same acid, 18k gold (which contains 75% gold) will be more resistant than 17k gold (which contains approximately 70% gold).

The touchstone test involves visually comparing the effects of acid on a rubbing of an unknown metal with rubbings from test needles of known purity. This test indicates the quantity of precious metal present and is used by agencies and businesses involved in checking gold products. Governmental and customs assayers overseeing the importation and sale of fine jewelry around the world use the system daily.

When all other visual, tactile and empirical information leads you to believe that an item is made of a solid gold alloy, you can use the touchstone test to determine the quantity of gold (karat or fineness) in the sample. This essentially is a comparative test in which two or more samples are rubbed on the stone and treated with acid side by side. Acid tests are most effective for gold al-

11. Paper towel is used to soak up excess solution.

12. The 12k rubbing has turned brownest and is nearly gone. The rubbing from the sample ring has reacted slightly, while the 14k rubbing shows almost no effect from the acid. Clearly the unknown sample's reaction is closer to 14k than to 12k, although the sample has reacted slightly more than the 14k rubbing. Thus the sample is determined to be approximately 13½ karat.

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loys between 9k (.375 fine) and 18k (.750 fine). Outside that range, differentiation becomes more difficult.

Note: Testing gold alloys of different colors requires test needles of the appropriate colors as well. White golds which may include a variety of precious and nonprecious components do not produce definitive test results. Dental golds, which frequently are hardened by adding small amounts of platinum, likewise do not test well.

Procedures for touchstone testing of gold items:

1. Apply one drop of oil to a clean black touchstone (Figure 6). Use your finger to rub the oil into the surface of the stone.

2. Select an area where rubbing will result in minimal damage to the work. Do not test on a solder seam, which may give an inaccurate reading. Rub the item in question back and forth against the stone, depositing a solid band or stripe of metal on the surface (Figure 7). Use the item to write a note indicating that this stripe is from the unknown sample.

3. To the left of the stripe, make a similar mark with a test needle which you guess is slightly lower in quality than the sample, and make a note to indicate the fineness (Figure 8). The rubbings should be side by side, and of identical size and intensity. Compare the feel and visual appearance of the two rubbings for further clues. Rubbings made from gold alloys of higher karat feel softer, require less effort, emit a duller sound and leave a deeper yellow stripe.

4. To the right of the unknown stripe, make an identical rubbing using the test needle of the next higher quality, with a note of its fineness or karat (Figure 9).

5. Use the appropriate acid solution (see table) to deposit an even stripe of liquid across the rubbings (Figure 10). The alloy of the lowest quality will react first and turn the brownest as the acid etches the nonprecious components of the metal away. Allow the acid to sit for 5 to 30 seconds, or until at least all but the highest quality rubbing have had a chance to react.

6. Use a paper towel to soak up excess acid so that visual inspection is easier (Figure 11). Use care not to allow the acid soaked portion to contact your skin. Discard the paper towel carefully and safely.

7. Inspect the rubbings closely and observe the effects of the acid (Figure 12). The rubbing with the lowest gold content will be the brownest. The rubbing with the highest gold content will be most resistant. By comparing the reactions you can determine the fineness of the unknown sample. To clean the stone, flush it with water while using a plastic abrasive pad to remove the rubbings.

Qualitative test for platinum: Platinum and its alloys are the most resistant to acids. Aqua regia can be used to differentiate platinum and its alloys from other white metals such as white gold, silver and nickel.

1. Make a series of rubbings of the metals in question on an oiled touchstone. Indicate the source of each rubbing. Apply a small amount of the platinum testing acid (aqua regia) across the rubbings (Figure 13).

2. Carefully use a paper towel to absorb excess solution. Inspect the effects of the acid on the various metals (Figure 14). The platinum rubbing is unchanged, while rubbings of all other metals are immediately etched.

Summary: The testing of precious metals is a valuable and easily learned skill. By following the procedures outlined above safely and carefully, you can learn a great deal about items of questionable origin, and determine their content with accuracy. Above all, experience makes testing easier and increases the accuracy of the results.

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13. Applying a stripe of aqua regia across the rubbings made by various white metals: platinum, 14k white gold, sterling silver and nickel.

14. Reactions to aqua regia (from top to bottom): The platinum rubbing is unchanged. However, the acid almost completely removes the 14k white gold, sterling silver and nickel rubbings.

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