

# XRF Analysis of Coins in Slabs etc

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Some time ago I was asked if I could check the composition of a medal, allegedly silver, but with an odd surface texture and toning. When it arrived it was housed in a bezel with thick glass lunettes. Having previously experimented with a portable XRF analyser, I was not optimistic, as the sheer mass of material between the X-ray source/detector and the surface would significantly attenuate the X-rays going in and coming back. As expected the results made no sense.

More recently a question was raised on an online forum about checking the metal composition of a coin in a slab<sup>(1)</sup>. This had arisen after some publicity material appeared from one of the main manufacturers of hand-held, portable XRF analysers suggested that a measurement could be made through a slab<sup>(2)</sup>. The article was also cautioning against fake coins in fake slabs which more worryingly had valid numbers on the Third Party Grader's (TPG's) website.

The following pages present a few tests of a portable XRF analyser (Niton XL2 GOLDD) from Thermo Fisher, which is part of Thermo Scientific. The unit has an extended metals and elements calibration, not just the usual precious metals, and can test minerals, corrosion products and some of the more unusual alloys used by counterfeiters. For the results presented below, only the basic metals were tested. Readings considered good are coloured green, possibly acceptable readings amber, and very wrong are in red.

Along with a reference measurement, in air, four different plastics were tested: (1) Mylar lined coin flip, (2) PVC bag, (3) PVC flip, and (4) a slab. The slab appears to be made from polycarbonate rather than acrylic. The plastics are illustrated below, along with a measurement of the thickness of a single layer of the material.



Mylar flip – 0.015mm



PVC Flip – 0.14mm



PVC Bag – 0.025mm



Slab – 1.66mm

**2002 gold proof 5 pence.** Should be 22 carat gold, 91.7%.

Reference	Au 91.1%, Cu 8.4%, Zn 0.1%, Ag 0.1%
Mylar flip	Au 91.0%, Cu 8.4%, Mo 0.1%, Bi 0.1%, Zn 0.1%, Ag 0.1%
PVC Bag	Au 90.0%, Cu 8.4%, Se 0.6%, Nb 0.1%, Bi 0.1%, Ag 0.1%
PVC Flip	Au 88.2%, Cu 5.5%, Se 2.7%, Mo 1.5%, Nb 0.9%, Bi 0.5%, Ag 0.2%
Slab	W 73.7%, Nb 10.3%, Se 5.6%, Mo 3.8%



**1858 shilling.** Should be fine silver, 92.5%.

Reference	Ag 93.3%, Cu 6.2%, Pb 0.2%
Mylar flip	Ag 93.4%, Cu 6.2%, Pb 0.3%
PVC Bag	Ag 93.4%, Cu 6.2%, Pb 0.3%
PVC Flip	Ag 96.0%, Cu 2.4%, Pb 0.3%, Zn 0.2%, Nb 0.1%
Slab	Ag 95.2%, Cu 1.4%, Nb 1.4%, Sb 0.6%, Mo 0.4%, Pb 0.2%



**1947 shilling.** Scottish design. Should be CuNi, 75% Cu, 25% Ni.

Reference	Cu 76.7%, Ni 22.3%, Mn 0.2%
Mylar flip	Cu 76.9%, Ni 22.9%, Mn 0.2%
PVC Bag	Cu 77.0%, Ni 22.8%, Mn 0.2%
PVC Flip	Cu 79.0%, Ni 18.3%, Mo 0.9%, Nb 0.6%, Pb 0.4%, Zn 0.3%
Slab	Al 90.9%, Cu 6.8%, Ni 1.7%, Nb 0.4%, Mo 0.1%



**1691 Limerick halfpenny** overstruck on a gunmoney shilling

Reference	Cu 91.6%, Sn 5.5%, Pb 2.0%, Sb 0.3%, Zn 0.3%, Ni 0.1%, Ag 0.1%
Mylar flip	Cu 91.7%, Sn 5.5%, Pb 1.9%, Sb 0.3%, Zn 0.3%, Ni 0.1%, Ag 0.1%
PVC Bag	Cu 91.9%, Sn 5.4%, Pb 1.9%, Sb 0.3%, Zn 0.3%, Mo 0.1%, Nb 0.1%
PVC Flip	Cu 81.4%, Sn 12.5%, Pb 3.2%, Sb 0.7%, Zn 0.9%, Mo 0.5%, Nb 0.4%
Slab	Al 91.3%, Cu 7.2%, Sn 0.6%, Nb 0.4%, Pb 0.2%, Mo 0.1%, Zn 0.1%



Thus making an XRF measurement through a slab gives almost random compositions. This is due to the way the built-in interpretation software tries to make a best fit to the X-ray spectrum coming back into the machine and scales the composition to give a total of 100%. The presence of a thick enough layer of plastic causes sufficient attenuation to cause the machine to fail to make a proper reading of the metal below, in some cases finding totally the wrong metal.

To confirm it is an attenuation effect, the 1947 CuNi shilling is retested with increasing numbers of the PVC layers cut from a flip.

Reference	Cu 77.29%, Ni 22.49%, Mn 0.173%, Fe 0.031%
PVC flip	Cu 77.67%, Ni 17.92%, Mo 0.781%, Nb 0.503%, Pb 0.427%, Zn 0.286%, Zr 0.100%
PVC flip ×2	Al 85.83%, Cu 10.95%, Ni 2.31%, Mo 0.205%, Nb 0.190%, Pb 0.139%, Zn 0.100%
PVC flip ×3	Al 94.85%, Cu 3.58%, Ni 0.576%, Mo 0.197%, Nb 0.200%, Pb 0.136%, Zn 0.138%

## Conclusions

The machine used for these tests is several years old (software/calibrations two years old) and while the interpretation software might have been improved since then, I can only conclude that using a portable XRF machine to determine the metal composition through a slab using the built-in interpretation software can produce erroneous results. It is possible to carry out your own interpretation of the X-ray spectrum, but that is very laborious and requires knowledge of some subtle x-ray spectra details and careful calibration methods.

## References

- (1) [https://www.facebook.com/permalink.php?story\\_fbid=699717384466605&id=100019062855930&story\\_index=12](https://www.facebook.com/permalink.php?story_fbid=699717384466605&id=100019062855930&story_index=12)
- (2) [https://www.thermofisher.com/blog/metals/can-xrf-technology-produce-accurate-analysis-on-a-coin-in-a-holder/?fbclid=IwAR3RfnPrRZtcRKjrEBxXtJuca5eAgcO6\\_cLK\\_-KD8JbKDYf\\_byfh-z9qYiA](https://www.thermofisher.com/blog/metals/can-xrf-technology-produce-accurate-analysis-on-a-coin-in-a-holder/?fbclid=IwAR3RfnPrRZtcRKjrEBxXtJuca5eAgcO6_cLK_-KD8JbKDYf_byfh-z9qYiA)

