Counterfeit Gold Coins

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Counterfeit Gold Coins

Agenda

• Method of analysis
• Types of counterfeit gold coins
• Detailed view of counterfeit gold coins with tungsten cores
• Conclusion
Counterfeit Gold Coins

The National Analysis Centre of the Deutsche Bundesbank is engaged in:

- scrutinizing counterfeit bank notes and coins
- classifying counterfeits
- collaborating with law enforcement authorities

In 2016 we encountered 33,000 counterfeit Euro coins compared to 1,570 counterfeit precious metal coins.
Methods of analysis
Counterfeit Gold Coins
Methods of analysis

Microscope

- Detection of minting defects such as depressions, raised lines or points on the front and back of the coin.
- Detection of defects in the edge lettering
- Easy comparison between the minting quality of the genuine coin and the potential counterfeit
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Methods of analysis

Specific gravity balance
- Easy way to determine the weight and the specific gravity (density) even of complex geometries
- Simple detection of poor counterfeits made out of steel, brass, zinc, lead etc...
- Approximation of the gold content by comparing the density with the existing density of gold alloys

Technical basis:
Archimedes’ Principle
weight in air : 41,728g
weight in water : 39,290g
\[ \rho = \frac{m}{v} \]
41,728g/2,438cm³=17,10g/cm³
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Methods of analysis

Handheld X-ray fluorescence spectroscopy
- High flexibility, delivers a good overview
- Penetration depth <0.05mm
- Very small area is checked <1cm²
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Methods of analysis

Measuring of the Electrical Conductivity

- Quick measurement
- Penetration into test specimen
- Penetration depth can be varied by the frequency
  - $100\text{Hz} \approx 12\text{mm}$, $120\text{kHz} \approx 0,4\text{mm}$
- Measurement through plastic foil possible (0,5mm)
- Bullions and coins can be tested with the seal unbroken
- Typical Unit: $\text{MS/m} \ (\text{Mega Siemens/m})$
- % $\text{IACS} \ (\text{International Annealed Copper Standard})$

- Typical Conductivities
  - Fine Gold (99,99%): 44MS/m
  - Krugerrand (91,67%): 9,7MS/m
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Methods of analysis

Projector

- Mainly used for the quality inspection of Euro circulation and Euro collector coins
- Very helpful in counting the number of mills
Types of counterfeit gold coins
Counterfeit Gold Coins
Types of counterfeit gold coins

1. Counterfeits with a significant gold content

Typical features:

• Gold content close to the original, typically between 450/1000 and 930/1000
• Deviation in the minting quality especially of the edge lettering
• Deviation in the number of mills
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Types of counterfeit gold coins

1. Counterfeits with a significant gold content
   Examples:

   - 20 Mark
     German Kaiserreich
   - 20 CHF (Swiss)
     „VRENEILI“
   - Sovereign
     Great Britain
### Counterfeit Gold Coins

**Types of counterfeit gold coins**

1. Counterfeits with a significant gold content

<table>
<thead>
<tr>
<th>50 MXP</th>
<th>Counterfeit</th>
<th>Genuine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (g)</td>
<td>41,67</td>
<td>41,72</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>17,11</td>
<td>17,13</td>
</tr>
<tr>
<td>Standard</td>
<td>893</td>
<td>895</td>
</tr>
<tr>
<td>Electric conductivity (%IACS)</td>
<td>14,8-15,3</td>
<td>15,1-15,4 (8,6-8,7MS/m)</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>37,07</td>
<td>36,96</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>2,65-2,72</td>
<td>2,72-2,75</td>
</tr>
</tbody>
</table>

Known in Germany since 1971!
Counterfeit Gold Coins
Types of counterfeit gold coins

2. Counterfeits with a non-gold base material

Typical features:

- Base Material is in general steel, zinc or a copper based alloy, new versions have a tungsten core
- Normally coated with a thin gold layer (<0.03mm)
- Can easily be detected through variations in outer dimensions and/or weight and magnetism (except tungsten)
2. Counterfeits with a different base material

<table>
<thead>
<tr>
<th>4 Ducats</th>
<th>Counterfeit</th>
<th>Genuine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (g)</td>
<td>11,950</td>
<td>13,958</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>8,40</td>
<td>18,97</td>
</tr>
<tr>
<td>Standard</td>
<td>63,4% Cu 36,3% Zn</td>
<td>986</td>
</tr>
<tr>
<td>Electric conductivity</td>
<td>25,8% IACS</td>
<td>26,2 MS/m 42,16% IACS</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>39,82</td>
<td>39,65</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>1,19</td>
<td>0,72</td>
</tr>
<tr>
<td>Groves / Mills</td>
<td>210</td>
<td>283</td>
</tr>
</tbody>
</table>
### Counterfeit Gold Coins

#### Types of counterfeit gold coins

<table>
<thead>
<tr>
<th>50 USD</th>
<th>Counterfeit</th>
<th>Genuine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (g)</td>
<td>33,919</td>
<td>33,947</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>15,89</td>
<td>17,62</td>
</tr>
<tr>
<td>Standard</td>
<td><strong>Tungsten</strong></td>
<td>916,7 Rest Copper and Silver</td>
</tr>
<tr>
<td>Electric conductivity %IACS</td>
<td>disturbed</td>
<td>18,4</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>32,71</td>
<td>32,69</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>2,76</td>
<td>2,82</td>
</tr>
<tr>
<td>Groves / Mills</td>
<td>160</td>
<td>161</td>
</tr>
</tbody>
</table>
Counterfeit Gold Coins
Types of counterfeit gold coins

Micrograph of a 50US tungsten counterfeit

Magnification with a light optical microscope

Source:
Forensic Institute of the Federal Criminal Police Office

Magnification with an Electron Microscope (SEM)
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Types of counterfeit gold coins

Microstructure of the inner core
Counterfeit Gold Coins
Types of counterfeit gold coins

Analysis of the outer layer

Gold coating
Intermediate layer of copper
Tungsten core
Counterfeit Gold Coins
Types of counterfeit gold coins

- The microstructure of the core consists of tungsten grains of different sizes, which are embedded in a copper matrix.
- The chemical composition of the core can be described as 90% tungsten and 10% copper.
- To achieve a better connection between the base material and the gold layer the tungsten core is coated with copper. Beside gold the outer layer also contains approximately 4% copper and 1% aluminium.
- The thickness of both layers together varies between 10µm and 35µm.
Conclusions

• Counterfeit coins appear in different variations
• For a thorough examination more than one method of analysis should be applied
• To increase the hurdle for counterfeiters it might be worthwhile to discuss the use of security features for modern coins
Counterfeit Gold Coins

Thank you very much