Gold ruby an environmental friendly red colour

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Aim: Better understanding of gold ruby and if possible achieve colouration without heat treatment
Red colours

Gold ruby

Selenium

Cupper ruby

Cadmium
Gold ruby- development

\[ \triangle = \text{grundglasets beståndsdelar} \]

\[ \bullet = \text{färgande kolloidala komponenter} \]

10-80 nm
Gold ruby - colour

Visually determined

<table>
<thead>
<tr>
<th>Weak</th>
<th>Normal</th>
<th>Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Gold ruby</td>
<td>Amethyst</td>
</tr>
<tr>
<td>Brown</td>
<td></td>
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</tbody>
</table>

Visually determined
Gold ruby - colour

Spectrophotometrically determined

Colour coordinates
+a amount red
+b amount yellow
-b amount blue

Brown
Red
Amethyst
Gold ruby

Gold ruby - colour

Spectrophotometrically determined

Colour coordinates
+a amount red
+b amount yellow
-b amount blue

Brown
Red
Amethyst
Gold ruby
First part:
commercial glass composition

- Selenium and gold proportions

<table>
<thead>
<tr>
<th>Temperature</th>
<th>5 min</th>
<th>15 min</th>
<th>1h</th>
<th>15 h</th>
<th>48 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>525 °C</td>
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<td>550 °C</td>
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</table>
Industrial melt

- Two pot melts
- Producing mainly bowls
- Flame polishing
- Heat treatment
- Different mixing of gold raw material with batch
  1. Adding the gold raw material as it was
  2. Grinding and mixing gold with lime, crushing pellets somewhat

0.02 weight% gold
0.005 weight% selenium dioxide
0.5 weight% tin dioxide

550 °C

1h - 5h - 10h

2 min - 4 min

Flame polished
Industrial melt- results

Similar results from both melts

550 °C: 96 h  48 h  15 h  5 h

Melt 1  melt 2  melt 2

Zink cords
Second part: simplified composition

Additions:

- Gold solubility
- Nucleation
- Growth
Gold Solubility

- Very low
- Hard to measure
  - difficult to distinguish between solubility nucleation and growth

Bottom of crucible

Light microscope

20-30 μm gold particles in most glasses
Development influence by single components

Antimony     Tin     Selenium     Cerium     Lead
Bismuth     Titanium     Iron     Phosphorous
Selenium

100 pm Au, 25 ppm SeO₂

Oxidating
No addition
Reducing

250 ppm SeO₂
50 pm Au
No Au
Gold, selenium + one addition

Antimony | Lead | Bismuth
---------|------|--------
Titanium | Iron | Tin
Conclusion

- Selenium the most important addition - problematic
- So far heat treatment in commercial batch is needed
- Possible to develop a commercial glass that strikes directly