**GOLD CASTING ALLOYS**

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http://www.dent.unc.edu/portfolios/bayne/dental-materials/

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**GOLD AND GOLD ALLOYS**

History of Use in Dentistry

Lost wax casting process: 1907, William Taggart.  
(see the ADA history website)

http://www.vekagesta.nl/cast_inv.html

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**INDIRECT RESTORATIONS**  
Review of Errors

**ERRORS:**

- Impressions: 0.1 to 0.2%
- Models/Casts: ----
- Waxing: ----
- Investing: +1.5 to 1.7%
- Casting: -1.5 to 1.7%
- Finishing/Polishing: ----
- Cementing: ----

Calculation of ideal permissible error:  
\[ 2 \times 25 \mu m / 10,000 \mu m = 0.5\% \]

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**GENERAL REQUIREMENTS**

**Mechanical Properties:**

- High E (stiffness)
- Moderately high YS and H (resistance to plastic deformation)
- Hardenable by heat treatment (retention of polish)

**Biological Properties:**

- Biocompatible: no toxic soluble phases
- Non-reactive in the oral environment

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**REVIEW OF CORROSION**

1. Types:  
   - Chemical Corrosion, Electrochemical Corrosion

2. Requirements for Electrochemical Corrosion:  
   - Anode, Cathode, Circuit, Electrolyte

3. Electrochemical Corrosion Categories:  
   - Galvanic Corrosion (macro-galvanic)
   - Local Galvanic Corrosion (structure-selective corrosion)
   - Concentration Cell Corrosion (crevice corrosion)
   - Stress Corrosion
CLASSIFICATION OF ALLOYS

1. Full Gold Crown and Bridge Alloys (based on precious metals)
   a. ADA Classification System (see phase diagrams)
      (1) Type I \( \geq 83\% \) Au (Non-heat hardenable) -- inlay
      (2) Type II \( \geq 78\% \) Au (Non-heat hardenable) -- inlay, onlay, ...
      (3) Type III \( \geq 78\% \) Au (Heat hardenable) -- onlay, crown
      (4) Type IV \( \geq 75\% \) Au (Heat hardenable) -- crown, bridge
   b. Effects of Alloys Components:
      (1) Gold (Au) → Corrosion resistance
      (2) Copper (Cu) → Hardness
      (3) Silver (Ag) → Counteract orange color of copper
      (4) Palladium (Pd) → Increase MP and hardness
      (5) Platinum (Pt) → Increase MP
      (6) Zinc (Zn) → Prevent oxidation during melting (O\textsubscript{2} getter)

TERMINOLOGY

1. Precious Metal = containing metals of high economic value such as gold, platinum, palladium, silver, (rhodium), (iridium), (gold, platinum, palladium, silver, (rhodium), (iridium), (rhuthenium), and (osmium).
2. Noble Metal = a precious metal that is resistant to tarnish. This excludes “silver” by definition.
3. Low Gold Alloys = Alloys containing <75% gold (less than 50 a/o gold) which means that gold atoms represent less than every other atom.
4. Gold-substitute Alloys = precious metal alloys not containing gold.
5. Base-Metal Alloys = alloys not containing precious metals to impart their corrosion resistance.

COMMERCIAL EXAMPLES

<table>
<thead>
<tr>
<th>No.</th>
<th>Alloy Type</th>
<th>Impurities</th>
<th>Fusion Met</th>
<th>Liquidus</th>
<th>LCTE °/°C</th>
<th>Tm °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type I</td>
<td>0.1</td>
<td>17.4</td>
<td>1.7</td>
<td>15.5</td>
<td>790</td>
</tr>
<tr>
<td>2</td>
<td>Type II</td>
<td>0.2</td>
<td>16.8</td>
<td>1.6</td>
<td>15.0</td>
<td>790</td>
</tr>
<tr>
<td>3</td>
<td>Metal</td>
<td>0.3</td>
<td>15.6</td>
<td>1.5</td>
<td>14.0</td>
<td>790</td>
</tr>
<tr>
<td>4</td>
<td>Type III</td>
<td>0.4</td>
<td>14.8</td>
<td>1.4</td>
<td>13.0</td>
<td>790</td>
</tr>
<tr>
<td>5</td>
<td>Type IV</td>
<td>0.5</td>
<td>13.6</td>
<td>1.3</td>
<td>12.0</td>
<td>790</td>
</tr>
</tbody>
</table>

PROCESSING CYCLES

<table>
<thead>
<tr>
<th>CAE2</th>
<th>Gold Alloys</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_a )</td>
<td>590°C</td>
</tr>
<tr>
<td>( T_b )</td>
<td>890°C</td>
</tr>
</tbody>
</table>

Alloy LCTE = 16-18 ppm/°C
CASTING PROBLEMS
for Gold Alloys

A. Distortion:
1. Margins: Probability highest in thinner portions of pattern.
   a. Wax Deformation: Improper removal or handling of pattern.
   b. Premature Quenching: wait until button loses red color.
   c. Investment Expansion/Contraction:

B. Surface Irregularities:
1. Fine Surface Roughness: Inherent particle size of investment
   a. High W/P ratio increases surface roughness.
   b. Low W/P ratio decreases investment adaptation or flow.
   c. Prolonged burnout encourages investment decomposition.
   d. Overheating alloy encourages investment decomposition.
   e. Overheating alloy encourages reaction with investment.
2. Surface Defects:
   a. Nodules: air bubbles trapped on the pattern during investing.
   (Use surfactant; paint pattern; vacuum invest; vibrate)
   b. Ridges or Veins: poor wetting causing water films on pattern.
   (Use surfactant; vacuum invest; vibrate investment carefully).
3. Gross Surface Defects:
   a. Fins: cracked investment (from overheating)

C. Incomplete Castings:
1. Internal Porosity: due to improper solidification.
   a. Improper Spruing: Diameter too small or too long.
   b. Low Temperature: Investment or metal too cold.
   c. Included Gases: Contaminated gold or oxidized old gold.
   d. Occluded Gases: Improper burnout of pattern.
2. Incomplete External Shape:
   a. Insufficient casting pressure.
   b. Excessive back pressure from investment.
   c. Suck back into sprue.

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