Some Do’s and Don’ts when selecting alloys to be used with implants.
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Selecting the proper alloy for implants is generally an easy job. Most PFM alloys are strong enough for use with implants and little consideration is given to the actual stresses and environment the alloy would be experiencing once in service. Our experience over the last twenty-plus years has indicated there are some guidelines that should be followed. That is the purpose of this article: to provide you with some Do’s and Don’ts when choosing alloys to be used in conjunction with implants.

Strength Considerations
The vast majority of alloys used for porcelain-fused-to-metal have adequate physical properties for use with implants. The same is not true for regular casting golds.

**Do not** use a Type 3 alloy when casting bridgework for use with implants.

**Do** use a Type 4 casting gold alloy for bridgework and custom abutments.

By necessity, an implant will concentrate mastication stresses at the connection point with the restoration. Only Type 4 casting golds have sufficient physical properties to tolerate the forces that will be experienced by the restoration. The next questions are then ‘How strong should the alloy be?’ and ‘How do I harden the alloy?’ The first question is determined by the design at hand. The longer the span the stronger the alloy needs to be. As to the second question:
For the Type 4 casting golds physical property charts list two conditions, soft and hard. How the alloys are processed determine the alloy’s strength. Some variations are:

- Waiting until the alloy button loses its red color and then quenching the ring in water. The alloy will have properties above the soft condition.
- Allowing the ring to bench cool. The alloy will have properties between the soft and hard condition.

Follow (1) or (2) above and then heat the casting to 350°C hold for 15 minutes and air cool. This process will harden the alloy to those properties listed under the ‘hard’ condition.

Other strength considerations:
- **Single Gold Crowns:**
  A type II / III gold alloy works very nicely as either a cemented unit over a stock titanium abutment or a stand alone screw retained crown.

- **Single Unit Porcelain Fused to Metal crowns:**
  An all ceramic crown will not mask out a metal abutment. Type II or III is acceptable in the anterior smile zone. Posterior or splinted units that require more strength should be cast in a stronger Type IV alloy.

- **Custom Abutments:**
  Often times a custom abutment will replace a portion of the root, correct the geometric angle, provide a natural emergence profile, and support a crown. Always use a Type IV alloy for multipurpose abutments.
Chemical Resistance

Palladium-silver alloys have poor resistance to strong halogens (chlorides, iodides and bromides). Sterilizing solutions and disinfection solutions may contain halogens that will attack and corrode the alloy. The corrosion products leave unsightly blotches on the alloy surface. The chemical attack may adversely affect the strength of the alloy structure as well.

*Do not use palladium-silver alloys for haders bars and super-structures.*

The silver free palladium alloys, gold-palladium and gold-platinum alloys have sufficient resistance to halogen solutions.

Wear Resistance

It is generally accepted that the hardness of a material can provide a convenient measure of how the object will wear when in contact with another object. In other words, when two objects come in contact, the object with the higher hardness will abrade an object with a lower hardness. This ‘rule-of-thumb’ works well for most situations but another factor comes into play when gold is involved: shear modulus. The shear modulus of gold is extremely low. This is the energy necessary to move one layer of atoms over another. The low shear modulus is the property that allows gold to be reduced so thin that light can pass through the film. While this property is one of the features unique to gold, it is detrimental when we are mating a cast gold alloy surface (female) to a plastic male pin.

*Do not use a gold alloy where the female portion is a cast alloy and the male portion is nylon.*  
*Do use a high palladium alloy for maximum wear resistance.*

The nylon pin will abrade the cast gold alloy female rendering the appliance useless. Replacing the pin with an oversize pin will restore functionality for a while, but eventually the larger pin will continue to abrade the gold alloy making the hole even larger.

Galvanic reactions and non-precious alloys

Whenever two dissimilar metals are in contact with each other an electrical current is generated. The consequence of the current is dependent upon the materials and environment. Multiple studies have been conducted on the effects of alloys in contact with titanium implants. Interestingly the studies have been conducted independent of each other but the results are quite consistent.

*Do not use non-precious alloys in conjunction with implants.*

Nickel or cobalt based alloys will corrode when in contact with titanium. Table 1 shows the electrochemical potential for the different alloy systems as determined by the studies. For any two alloys, the alloy higher on the list will corrode the lower one.
Table 1
Alloy Electrochemical scale

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<table>
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<tbody>
<tr>
<td>A</td>
<td>High gold PFM alloy</td>
</tr>
<tr>
<td>B</td>
<td>Palladium PFM alloy</td>
</tr>
<tr>
<td>C</td>
<td>Gold Casting alloy</td>
</tr>
<tr>
<td>D</td>
<td>Titanium</td>
</tr>
<tr>
<td>E</td>
<td>Cobalt Chromium</td>
</tr>
<tr>
<td>F</td>
<td>Nickel Chromium</td>
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All of the noble metal based alloy will corrode titanium and titanium will corrode all of the non-precious alloys. Now the question is how clinically significant is this result? In the case of titanium corrosion the reaction is the formation of titanium dioxide. This reaction is extremely fast and because titanium oxide is adherent, and an excellent insulator, the reaction stops immediately. Therefore, the galvanic reaction between the noble metal alloys and titanium is not clinically significant.

For the case of the non-precious alloys coupled with titanium, however, it is the non-precious alloys, not the titanium that will corrode. Unfortunately, the non-precious alloys do not form oxides that prevent the passage of a current (they are not as good insulators as the titanium oxide). The corrosion reaction continues for as long as the metals are in contact. This will probably lead to crevice corrosion that will compromise the strength of the appliance. Therefore, the galvanic reaction between the non-precious alloys and titanium is clinically significant and should be avoided.

Summary
These are a few considerations when choosing an alloy to be used with implants. As you know most alloys work very well but there are some factors that require consideration.
Special thanks to Pittman Dental Laboratory for their astute observation of this phenomenon.

