SELECTING ALLOYS FOR IMPLANT APPLICATIONS

PAUL J. CASCONE

Selecting the proper alloy for implants is generally an easy task. 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.

Experience over the last twenty-plus years has indicated there are some guidelines that should be followed. The purpose of this article is to provide 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 i) 'How strong should the alloy be?' and ii) '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:

1. 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.
2. Allowing the ring to bench cool. The alloy will have properties between the soft and hard condition.

Follow either (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.

Paul J Cacsone
Senior Vice-President, Technology
Argen Corporaiton,
San Diego, CA 92121-4718 USA

Other strength considerations

Single Gold Crowns

A type II / III gold alloy works well 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[1]

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[2,3,4] 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.*

References

1. Special thanks to Pittman Dental Laboratory for their astute observation of this phenomenon.
2. Zurcher MH. Study of Galvanic Corrosion between Dental Alloys. Biocompatibility, allergies and resistance to corrosion: a global scientific approach, METALOR, 1993; 43-53.
3. Cortada M, Giner L, Costa S, Gil FJ, Rodriguez D, Planell JA. Galvanic corrosion behavior of titanium implants coupled to dental alloys. J Mater Sci Mater Med. 2000 May;11(5):287-93.
4. Taher NM, Al Jabab AS. Galvanic corrosion behavior of implant suprastructure dental alloys. Dent Mater. 2003 Jan;19(1):54-9.