Last month we started up a new series called “Treasure trove” to provide you with some background knowledge and interesting revelations about some of the exotic metals associated with stainless steels. Already we have found someone willing to take over this column for us in the immediately forthcoming magazine editions. He is none other than John Schmidt, Director of New Product Development at Ulbrich Stainless Steels and Special Metals.

Titanium; What melts in your mouth but not in your hand?

What melts in your mouth but not in your hand? That's right – titanium dioxide, one of the myriad forms of titanium used in modern business and industrial applications. .... Or were you going to say M&Ms™, the American candy that made the "melt in your mouth but not your hand" question famous in its ad campaigns? Well, you're still right. Because titanium in the form of titanium dioxide is an ingredient in the food coloring that is used to paint the little M on the individual candies [1].

John Schmidt, Director of New Product Development, Ulbrich Stainless Steels and Special Metals

The above example is a perfect introduction to titanium which is one of the most versatile metals in modern use. Not only can it be eaten and digested – in small amounts in some forms – its uses include components for buildings, aircraft, bridges and even medical implants, with many other functions in between. In fact, there are so many uses for titanium, especially as compounds or alloys, that only five percent of the titanium mined worldwide is used in its metallic form.

Nonetheless, titanium bears the brunt of the demand for a strong, yet lightweight metal that is corrosion resistant, particularly to bodily fluids, enabling its use in medical applications.

Various medical related applications.

Titanium's corrosion resistance properties provide not only the perfect material for major construction projects that will often be exposed to the elements, but also for miniscule applications within the human body that will be exposed to different but equally corrosive elements.

Characteristics of titanium

Titanium – Ti	
Atomic number:	22
Atomic Mass:	47.90
Electro negativity:	(Pauling) 1.5
Melting point:	1660 °C
Boiling point:	3287 °C
Element Classification:	Transition Metal
Appearance:	Shiny, dark-gray
Covalent Radius (pm):	132
Ionic Radius:	68 (+4e) 94 (+2e)
Atomic Radius (pm):	147
Atomic Volume (cc/mol):	10.6
Specific Heat (@20°C J/g mol):	0.523
Fusion Heat (kJ/mol):	18.8
Evaporation Heat (kJ/mol):	422.6

Titanium melts at 1,660 +/- 10°C and boils at 3,287°C. Pure titanium has a lustrous white color. Its specific gravity is 4.54, with a valence of 2, 3, or 4. Titanium is ductile only when it is free of oxygen, and hydrogen. Titanium is dimorphic, with the hexagonal form slowly changing to the cubic b form around 880°C. The metal combines with oxygen at 500 to 790 °C [2].

Among the more common titanium alloys that are found in medical devices are commercially pure Grades One through Four, TI 3%Al/2.5%V, GRADE9, AND 6AL4V and 6AL4V ELI, made from 6% aluminum and 4% vanadium, which are prized because of their non-invasive properties [3].

When titanium is used for medical devices and implants it presents less risk of rejection by the human body than many other metals. When this is combined with other essential properties titanium becomes a preferred metal for internal medical uses including joint replacement, as well as heart and back surgery implants. For internal medicine applications titanium can be found in shielding for pacemakers, and for a wide range of other implanted devices including those that regulate the heart or regulate internal release of pharmaceuticals. In addition to the implants themselves titanium is used in numerous devices such as pins and screws that attach the implants to the body. But internal medicine is not the only place to find medical uses for titanium. Titanium's relatively light weight and strength, durability and totally non-magnetic properties have provided another niche in the medical instrument industry for tools ranging from retractors, forceps, and even drills to highly technical equipment such as MRIs.

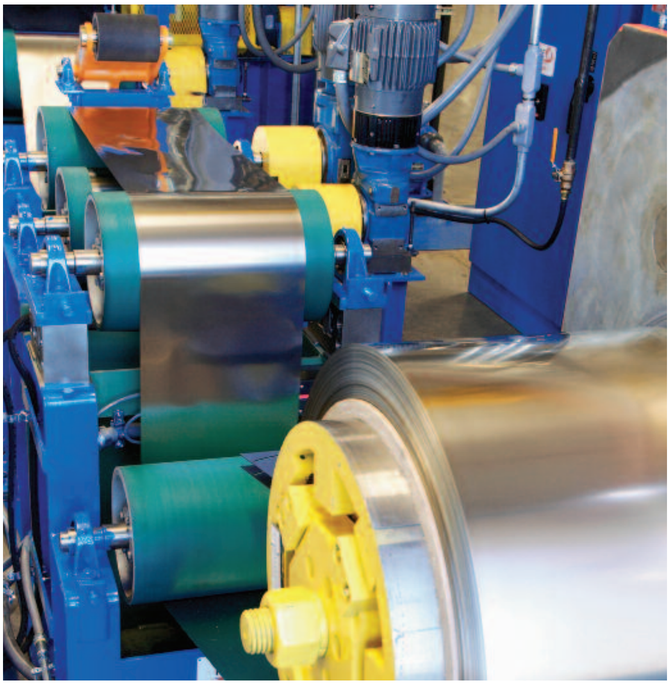
Ulbrich Stainless Steels & Special Metals (www.ulbrich.com) processes precision titanium strip and foils for medical implants, shields/cans for pacemakers, defibrillators and an increasing array of neuro-stimulator devices as well as the batteries and capacitors that power those devices.

Chemical processing industries use titanium foils for structured packing in distillation columns, specifically for terapthalic acid production, as well as gaskets and seals in the process. Other applications for titanium foils from Ulbrich include the production of hydrogen in hydrolyzers from water; foils for the production of structural honeycomb used in aero structures; and foils for the production of composite materials used in aero structures.

One of the most appealing aspects of titanium as opposed to other structural metals is that it can be as strong as steel, but weighs only about half as much. In the same vein, it is slightly heavier than aluminum but twice as strong.

Titanium is indeed one of the most versatile metals on the Periodic Chart of the Elements. And considering that in addition to all its other properties, it can be used in food applications, perhaps it is not too much of a stretch to expect that in the near future, a titanium-related food additive will spawn a new advertising slogan – "Finish your titanium, dear. It's good for you."

Cold rolling operators controls.



Annealing titanium strip.

References

[1] http://www.intlfoodcraft.com/food-color.html
[2] http://chemistry.about.com/od/elementfacts/a/titanium.htm
[3] http://www.atu.edu/ces/drgoswami/biomat.pdf

John Schmidt is Director of New Product Development at Ulbrich Stainless Steels and Special Metals. He holds a BS in Metallurgical Engineering, Magna Cum Laude, from Drexel University and then served in the Peace Corps in the Philippines. He joined the Lukens Steel Company thereafter and served in ever increasing capacities in technical sales development, marketing and product development, including at the American Iron and Steel Institute and as a liaison to the National Research Council. Schmidt then joined Haynes International (then the High Performance Alloy Division of Cabot) and revamped its technical marketing for the Eastern U.S. and Canada. In 1993, he joined Ulbrich Stainless Steels and Special Metals. His professional organizations include ASM, and the International Titanium Association, among others.