SSAT-2041CF Beta-Titanium Alloy Suitable for Cold Processing

Tsutomu TAKECHI
Manager, Titanium Department of Sumitomo Metal Industries, Ltd. Tokyo, JAPAN

SSAT is the abbreviation of “SUMITOMO Super Alloy Titanium”. 20 means 20% Vanadium, 4 means 4% Aluminum, 1 is 1% Tin. "CF" is cold formability.

Today, I would like to explain why we developed this particular alloy and how we pioneered new application with the short history including some topics. I am showing you the contents in the following pages.

This presentation consists of three parts. In the 1st part I will explain the short history about the SSAT-2041CF. I also refer to the background of developing history, and some topics of pioneering new application. I hope you can find not only the information about this alloy, but also the typical Japanese working style. In the 2nd part, I will explain the ideas forward from today we bear in mind looking for new applications. In the last part, I will explain the conclusion.

The preliminary objective of developing SSAT-2041CF was applying titanium alloy to the automotive with a view to lightening the body weight. We aimed to change the material of valve retainer from steel to SSAT-2041CF. As the valve retainer was made by cold forming process with steel at that time, we should propose cold formable titanium alloy. But as commercialized titanium alloys then had too much deformation stress, they couldn’t be applied.

So, the target of developing new titanium alloy becomes “Improve formability”. We set the target as shown, 20% down of cold deformation stress comparing to other common beta-titanium such as 15V-3Cr-3Sn-3AL.
We did many researches and tests for about 5 years with a certain car maker. They came
to produce the valve retainer in the end of the day in cold process with our
SSAT-2041CF, but some business reason hindered them from continuing to use this
material. Anyway, we developed our new beta-titanium alloy “SSAT-2041CF”.

Then, we researched the emerging market to apply our SSAT-2041CF and found the
fresh target. That was “the bicycle gear”. We had to clear 2 points. The 1st one was to
press the material into complex shapes designed by the computer. 2nd one was to have
it stand the strong instantaneous force. For example, a professional road racer appears
over 1000kg instantaneous force while racing. For these points, the idea of applying
SSAT-2041CF to the bicycle gear was basically acceptable. But we worked
cooperto cooperatively with the customer to fine-tune the material condition and application
technique.

So we collaborated with the customer for about 1 year. Finally, we got the ideal
condition to produce bicycle gear with our material.

This picture shows the bicycle gear produced with our beta-titanium, SSAT-2041CF.
The gear shaft is also made of SSAT-2041CF.

After we got the success, we started to find new application of SSAT-2041CF.Then we
met the golf club face. At that time, the trend of golf club, especially for the driver, was
to make a large club head with lighter weight. To catch up with this trend,
beta-titanium should be applied for this purpose. But there were no common techniques
to apply beta-titanium to the golf club fabrication. Then, we decided to do collaborative
work with a certain golf club fabricator. Although this cooperation succeeded, the road
for success was very tough. I am introducing you two topics about this.

The 1st topic is the mission to reduce cold press load at the fabricator. At first, they tried
to press SSAT-2041CF at the public laboratory center to find the press condition. But
their result was very terrible. They insisted that our material required too much press
load, which was about 80% over their maximum press load. So our collaborative work
team was sent to solve this problem. They worked of course so hard for over 1 week, forgetting to take rest.

Finally, they succeeded in reducing 90% press load by tuning press condition and developed some new techniques. But unfortunately, they needed some rest after that.

The 2nd topic was more serious. The crack occurred on the pilot produced Golf Club face while testing. So we had to tune the optimum aging condition to prevent it with the fabricator.

Here, I will explain you some aging characteristics of SSAT-2041CF. This figure shows the age-hardening curve. Aging response of SSAT-2041CF is faster than 15-3-3-3 beta alloy because of lower beta phase stability. This means the customer can save the aging heat-treatment cost.

Next figure shows aging characteristics. Mechanical properties can be controlled by selecting aging temperature and time.

By using aging characteristics data and many test results, the collaboration team tried to hammer out the optimum aging condition.

Finally, they succeeded in tuning optimum aging condition. Through their efforts, SSAT-2041CF was finally successfully applied to the golf club head.

Recent application example is the pole for ski. We produce the welded tube. Then the fabricator makes the pole for skiing. The ski pole for high level skiers requires the strong spring characteristic. This characteristic is obtained in the combination of high strength and low young module.
Hear I explain you shortly about Young module. The young module means the flexure property. The lower the young module is, the higher flexure property is obtained, which is characteristic in each material.

<Slide.21>
This figure shows the young module of SSAT-2041CF compared to other titanium alloys and CP-titanium. As you find, SSAT-2041CF has the lowest young module. This means it is the most suitable material for the ski pole. A Japanese ski player successfully competed in the TORINO winter Olympic games with a pair of ski poles made of this particular material.

<Slide.22>
I have explained application examples of SSAT-2041CF. Because we would also like to cultivate new markets, where the unique characteristics of SSAT-2041CF may be applied in the not very distant future. I am going to explain the two characteristics to you in the following pages.

<Slide.23>
SSAT-2041CF has good deep drawing formability. These pictures show the deep drawing test example. LDR shows 2.0 with 330 mm diameter press test.

<Slide.24>
Next is the figure of the fatigue strength for SSAT-2041CF. SSAT-2041CF shows about 600MPa fatigue strength after aging. We hope this characteristic is utilized for newer application, such as stressed parts in the aircraft.

End.
SSAT-2041CF
Beta-Titanium Alloy
suitable for cold processing

Tsutomu TAKECHI
Manager
Titanium Department
Sumitomo Metal Industries, Ltd.
SSAT-2041CF is ...

S : SUMITOMO
S : Super
A : Alloy
T : Titanium
20 : 20% Vanadium
4 : 4% Aluminum
1 : 1% Tin
CF : Cold Formability
Contents

1. SHORT HISTORY
   : Development
   : Pioneering Applications

2. FORWARD

3. CONCLUSION
1. SHORT HISTORY
Origin

Lighter Weight for Automobile

Valve Retainer

S45C (Steel)

Titanium!
Break through Point

Improve Formability

Cold Deformation Stress = 20% Less
(The same level as CP-Titanium)

... By identifying Chemical Contents
Result of five years
Research and Test
Good formability
But not applied ...
Try Again .. Bicycle Gear

<Required Points>
1) Pressed into Computer Designed Shape
2) Stand the Strong Instantaneous Force
Collaboration Work

Technical Meeting : Once a month
... For 1 year !

Tune the Material Condition
+
Discuss Forming and Aging Condition.
Result : Bicycle Gear

SSAT-2041CF

<Photo: SHIMANO, Inc.>
Next Step: Golf Club Face

<Trend>

Large Club Head

“Material”

Light & High Strength!

⇒ Beta-Titanium
Mission: Reduce Press Load

Target: Min. 80% Reduction
Result

90% Reduction!

By tuning press conditions (Ex. Lubricant / Die shape)

... After that, they needed some rest.
Collaborative Work Team (2)

Mission: Optimum Aging Condition

Crack occurred while testing
Aging Hardness

- Ti-15V-3Cr-3Al-3Sn
- SSAT-2041CF

Harden in Short Time

Hardness (Hv) vs. Aging Time (hr)

- 723K Aging
- Harden in Short Time
Aging Characteristics

Control Mechanical Properties by Aging

Graph showing aging time (hr) vs. tensile strength (MPa) at 673K, 723K, and 773K temperatures, and elongation (%) at different aging times.
Operation

The Collaborative Work Team tried to hammer out the optimum aging condition.

... After working over 50 hours continuously

The Sun looks yellow..
Result: Golf Club

SSAT-2041CF

Photo: Bridgestone Sports Co, Ltd.
Recent Application

The Pole for Ski

Photo: Japana Co, Ltd.
Young Module means ...

Lower Young Module means...

Higher Flexure
Young Module

The Lowest of Beta-Titaniums

SSAT-2041CF  Ti-15V-3Cr-3Al-3Sn  Beta-C  Ti-6Al-4V  CP(Gr.2)

Young Module (GPa)
2. FORWARD
Forward (1): Deep Drawing

$LDR = 2.0$ / with 1.76mm thickness, $D=330mm$
Forward (2) Fatigue Strength

Fatigue: 600MPa

Number of cycles (N)

Stress amplitude (MPa)

CR+773K × 5hr
CR+723K × 5hr
ST+773K × 32hr
ST+723K × 32hr

Non aging
Aging
3. CONCLUSION
SUMITOMO developed **SSAT-2041CF**, which is the most suitable for cold processing among the Beta-Titanium alloys.
SUMITOMO has expanded SSAT-2041CF sales for new applications such as the bicycle gear, golf club head and ski pole.
SUMITOMOO intends to pioneer newer applications, especially featuring higher LDR and fatigue strength properties.
Thank you for your attention!

Call Us! Anytime, anywhere.