Recent Developments in Beta Strip Alloys

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Outline

- Strip Manufacturing
- TIMETAL 21S
- TIMETAL 15-3
- Applications
TIMET Strip Production
Outline of Major Manufacturing Steps

VAR Ingot → Forge Slab → Continuous Vacuum Anneal (CVA)

Hot Roll → Cold Roll
Manufacturing of TIMETAL 21S by EBSM (Electron Beam Single Melting)

Initial EBSM trials have been promising and development is ongoing.

Physical, mechanical and metallurgical characteristics of a trial coil made using EBSM were similar to those of product made by VAR.

A full-scale component was successfully welded and cold formed.
TIMET Strip Production
Outline of Major Manufacturing Steps – EBSM Route

EBSM Slab → Bloom Slab

EBSM Slab → Bloom Slab

Hot Roll → Cold Roll

Cold Roll → Continuous Vacuum Anneal (CVA)
TIMET Strip Production
Trial Part Made with TIMETAL 21S EBSM

Part Made by EMFCO
Microstructure and Properties

• Microstructure
  – Beta Grain Size
  – Degree of Recrystallization

• Tensile Properties
  – Thermal Stability (21S)
  – Aging Response (15-3)
Aging of TIMETAL 21S

The two most common aging cycles for TIMETAL 21S:

- 593C (1100F) for 8 hours
- 691C (1275F) for 8 hours plus 649C (1200F) for 8 hours

The 1100F (593C) age is used for parts at moderate temperatures that require high strength. The 1275F+1200F (691C+649C) age is used for parts requiring maximum thermal stability. Usage of any particular condition depends, of course, on the specific temperatures, stresses, and expected service life.
TIMETAL 21S Microstructures After Aging

593C (1100F) for 8 hrs

691C (1275F) for 8 hrs

J. C. Fanning, Military Applications for Beta Ti Alloys TMS 2005
TIMETAL 15-3 Strip Tensile Properties

Each datum point for each aging cycle represents the average L and T value for a large amount of production data.

![Graph showing TIMETAL 15-3 Strip Tensile Properties](image-url)
TIMETAL 15-3 Applications

TIMETAL 15-3 strip is now utilized in the environmental control system ducting of several aircraft models, including the Boeing 777 and Airbus A380.
Example *TIMETAL* 15-3 Airframe Application
Bleed Air System on Airbus A380

REF: K.H. Rendigs, “Titanium Products Used at Airbus”
Example TIMETAL 15-3 Airframe Application
Environmental Control System on Boeing 777

REF: L. Fleming, “Beta Alloy Applications on the Boeing 777”
TIMETAL 21S Applications

For plug-and-nozzle and other types of exhaust systems, TIMETAL 21S is now used in lieu of much heavier nickel alloy systems on several aircraft models.
Example *TIMETAL 21S* Airframe Application
Plug and nozzle assemblies for Trent 800 on Boeing 777

Plug

Nozzle

1 meter

REF: L. Fleming, “Beta Alloy Applications on the Boeing 777”
Example *TIMETAL* 21S Airframe Application
Plug and nozzle assemblies for Trent 500 on A340-500/600

Summary

In the past decade beta strip alloys have proven useful in several aircraft applications, including TIMETAL 15-3 for pneumatic ducting and TIMETAL 21S for engine exhaust systems.