38.09.051-BA

Trappes, July 15th, 2009

DISTRIBUTION LIST: ***Participants and***

ERASTEEL SAS

V. POLARD
S. SELLA
A. RIOU
A. HOLMSTROM

AUBERT & DUVAL

P. HERITIER
Y-C. RICCI
J. C. ANDLAUER

ERASTEEL INC

T. HILL
A. LOBER

ERASTEEL COMMENTRY

R. BARET

ERAMET RESEARCH

J.P. CESCUTTI
J. MONTAGNON
C. MARCILLAUD (C. SILVERSTON)

ERASTEEL CHAMPAGNOLE

P. MICHEL

MEETING MINUTES : FACTORY VISIT, BROWN EUROPE LAVAL DE CERE

20260/2560

Participants:	***PBJTIPRO***	***P. BANIA***
	BROWN EUROPE	***M. GUY***
	BROWN EUROPE	***G. ROUSSILHE***
	ERASTEEL SAS	***L. SANCHO***
	ERASTEEL STUBBS	***A. PINHO DA SILVA***
	ERAMET RESEARCH	***B. ANTOLOVICH***

KEYWORDS : BRANCHE ALLIAGES°TITANIUM°ERASTEEL°DRAWING°

1. INTRODUCTION

This meeting was held as part of a larger project to develop transformation (conversion) capabilities for Titanium in the form of wire, wire-rod, bar, sheet and flat and squares. Paul BANIA has been retained in order to assist us with technical, marketing and prospecting aspects of the project. We have previously visited the Boonton factory which was described previously (38.09.045-BA). Following this visit, we will organize a visit to the factories at Commentry and Champagnole.

2. MINUTES

We arrived at the Brown Europe factory at approximately 9AM. After making introductions for each of the participants, we organized the visit and specified the goals for the visit.

The goals for the visit were :

- Acquaint Paul BANIA with the factory and industrial equipment to help orient his efforts
- Choose the format and material for industrial trials
- Describe the process map for the chosen formats
- Study each aspect of the process map for potential problems and establish a concrete action plan for the industrialization trials

2.1. GENERAL DISCUSSION

After the goals had been established, a general discussion was had describing the past and current activities of Brown Europe. Major points included :

- A highly customized production in 50% or the orders (formats) are seen but once a year
- Very heavy concentration in aircraft industry with some activity in the medical industry
- Lots of work for ALCOA
- In addition to geometric specifications, mechanical properties, grain size, surface conditions and inspections are frequently specified
- All coils are shaved and/or polished
- Principal materials systems are Ni base, Alloy steels and Stainless steels in 3-18mm sizes for coils and bars
- In addition to drawing benches, there exist two vacuum annealing furnaces (two ton load capability), water quenching and aging, pickling baths and electrolytic coating (Cu)and spray coating (MoBisulfate)
- Test certificates are retained for 30 years (at least !)
- Gol is to the have Quality system approved to NADCAP standards for testing and heat treatments within 3 years

Following the presentation of Brown Europe, Paul BANIA led a discussion on several of the particularities of titanium. Major points of this discussion include :

- Aeronautic markets require material which comes from a double melt process
- Aeronautic markets are broken down into airframe material and engine material of which the second is much more demanding in terms of certification requirements
- It is acceptable to develop a process route titanium from single melt sources (TiFast) which will not differ in the mechanical behavior seen during processing
- Great attention must be paid to avoid chlorine contamination
- Great attention must be paid to avoid hydrogen pickup although this is largely mitigated by the presence of the vacuum annealing furnaces which should be able to lower hydrogen pickup to 10-20ppm (attention to the possibility of intercoil bonding)
- During air cooling, must avoid staying in the 900-1100°F (480-600°C)

- Stress relieve temperature for Ti6-4 : 1300-1400°F (700-760°C)
- Recrystallization temperature for Ti6-4 : 1700°F (927°C)
- A significant memory effect is frequently seen with coil. This memory effect can be investigated using « capability » testing
- The pickling baths will probably need to be replenished more often than is actually the case and can probably be made with a 7 :1 nitric hydrofluoric composition. Measuring removal rates with a standard test piece is one way to check to see if the bath need be replenished.
- Baths should be temperature controlled and not exceed 80°C
- A specification for input stock could include the following elements :
    - Material to be alpha/beta worked below 8 inch (200mm)
    - Composition
    - Maximum thickness of alpha-case and oxygen pollution zone
    - Microstructure (uniform fine microstructure, alpha platelets, no evidence of grain boundary alpha, no transformed beta and no blocky alpha)
    - A macro slice taken at 4 inch (100mm) reroll

At this point, we made a factory visit to see the actual installations.

2.2. CHOOSE THE FORMAT AND MATERIAL FOR INDUSTRIAL TRIALS

The industrial trials are intended to establish a process route for material destined for use in the fastener segment of the aeronautic markets. A potential client has been established with whom Brown Europe already has a longstanding history.

The material for the industrialization tests was chosen to be Ti-6-4 (Ta6V).

It was decided to test three diameters for wire-rod and three diameters for bar. These include :

- 3mm, 7mm and 11,2mm for wire-rod
- 3mm, 10mm and 20mm for bar

These tests require input stock of 8mm, 13mm and 22mm. The 8mm stock will be used for the 3mm and 7mm diameters; the 13mm stock will be used for the 11,2 and 10mm diameters and the 22mm stock will be used for the 20mm diameter bar. Bruce ANTOLOVICH will coordinate the purchase of several coils from TiFAST for the purpose of these trials. Coils to be delivered to Eramet Research in order to maintain confidentiality of their final use within the group.

2.3. DESCRIBE THE PROCESS MAP FOR THE CHOSEN FORMATS

The process map for the chosen diameters for wire-rod and bar are shown below :

Process Map Bar					
Initial Size (mm)	**5**		**12**		**22**
Final Size (mm)	**3**		**10**		**20**
1	Blasting		Blasting		Blasting
2	Pickling		Pickling		Pickling
3	Coating		Coating		Coating
4*	Shaving/Polishing		Shaving/Polishing		Shaving/Polishing
5*	Coating		Coating		Coating
6	Drawing		Drawing		Drawing
7	Cleaning		Cleaning		Cleaning
8	Annealing		Annealing		Annealing
9	Coating		Flash Pickle		Flash Pickle
10	Drawing		Straighten		Straighten
11	Cleaning		Grinding		Grinding
12	Annealing		Inspection		Inspection
13	Flash Pickle				
14	Straighten				
15	Grinding				
16	Inspection				

Process Map Wire Rod					
Initial Size (mm)	**5**		**8**		**13**
Final Size (mm)	**3**		**7**		**11,2**
1	Blasting		Blasting		Blasting
2	Pickling		Pickling		Pickling
3	Coating		Coating		Coating
4	Shaving/Polishing		Shaving/Polishing		Shaving/Polishing
5	Coating		Coating		Coating
6	Drawing		Drawing		Drawing
7	Cleaning		Cleaning		Cleaning
8	Annealing		Annealing		Annealing
9	Coating		Flash Pickle		Flash Pickle
10	Drawing		Inspect		Inspect
11	Cleaning		Coating		Coating
12	Annealing				
13	Flash Pickle				
14	Inspect				
15	Coating				

2.4. STUDY EACH ASPECT OF THE PROCESS MAP FOR POTENTIAL PROBLEMS AN DEVELOP AN ACTION PLAN

Process Step	Main Difficulties	Potential Solution	Where	When	Who
Blast	is machine adapted to glass media	discussion with vendor	Brown Europe	July	Gilles R
Pickling	Bath make up needs to be verified	Chemical Analysis	Eramet Research	August	BA
	Bath effectiveness needs to be verified	Design of experiment with existing titanium stock	Eramet Research	August	BA
	Potential hydrogen pickup	Measurements	Eramet Research/Aubert & Duval	September	BA
Coating before polish	Shaving: will current tool work?	Run test with current tool	Brown Europe	October	GR
	Soap: is current soap ok	Test with TR408	Brown Europe	September	GR
	Soap: is current soap ok	Contact condat for other possible soaps	Brown Europe	September	GR
Polishing/shaving	Need to avoid Ti dust	Wet polish but current machine is not adapted, contact supplier for further options	Brown Europe	September	GR
	Need to avoid Ti dust	Peeling: talk to CarTech to get advice from Gem Maurer if possible	Eramet Research	July	BA
	Need to avoid Ti dust	Other industrial experience by visiting J&J Shasta	Boonton	?	AL/TH
Coating before cold or warm drawing					
Drawing (cold or warm)	When to draw cold, when to draw warm	Talk with Commentry for past experience	Eramet Research	September	BA
	When to draw cold, when to draw warm	Talk to Radyne for help	Peter Stubbs	September	AP
	When to draw cold, when to draw warm	Perform a warm drawing test	Peter Stubbs	October	AP
	When to draw cold, when to draw warm	Purchase final coil from customer and draw cold 7mm to 5mm	Brown Europe	September	MG
	What diameter capstan is needed to avoid memory effect				
	Stripper				
Cleaning after drawing			Brown Europe		
Annealing	Avoid to much hydrogen pickup or loss	Test with furnace at Brown Europe, analysis to be pi	Brown Europe, Eramet Research a	October	BA
		Discussions, with Bania, tests of supplied wire at			
	Ensure the appropriateness of the cycle	Eramet Research, Analysis of furnace using data supplied by GR	Eramet Research	October	BA
Flash Pickle	Same difficulties as other pickle but recall that we will only have 10% of the time for this pickle	See above; pickling tests to be done at Brown Europe	Eramet Research/Aubert & Duval		
Inspection coil					
Straightening	Are the dies appropriate	Use dies in alternative materials such as Bronze or plastic			
Grinding	Existing wheels are not adapted	Use alternative wheels			
Inspection/EC bars					
Coating coils (MoS2)					
Winding	What size is needed				

3. CONCLUSIONS

A plan for industrial tests for the production of three sizes of wire-rod and three sizes of bar of Ti6-4 has been established
An action list including who does what, when and where has been developed
The next meetings shall be held at the Commentry and Champagnole factories at the end of September, beginning of October depending upon the availability of the participants.
A summary shall be held at the Tour Montparnasse immediately following these two factory visits.