Advanced Technologies for Hard Metals Forming

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Titanium Europe 2016 – Paris
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• Why forming in hot condition?
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ACB/Aries Manufacturing – 150 employees
Aries Alliance – 250 employees
Core business - Aerospace industry

Hot Forming
Superplastic Forming

Linear and Rotary Friction Welding

Hot and Cold Stretch Forming

Milling

Elastoforming
Titanium

Aerospace Industry

Ti-6Al-4V

Extraordinary properties

But...
Why forming in hot condition?

Yield stress is very high at ambient temperature BUT decreases at high temperature

Forming at high temperature
- Reduced flow/yield stress
- Better bending ratio (up to 1)
- No springback
- No residual stress

Titanium Metals Corporation – Properties and Processing of TIMETAL 6-4
Superplastic Forming

Developed for the aerospace industry in the 70’s.

Technology required for complex shape parts
• Well adapted to deep parts or very complex shape
• Accurate and repeatable
• Reduces assembly

BUT
• Special material properties required (fine and equiaxed grains)
• Long cycle time (60 to 180 min)
• Thickness heterogeneity depending from part geometry
• α-case generation
• High temperature → die cost
High temperature process
• High nickel-content alloy for SPF dies
• Die-life to manage by material and design
• Thick α-case layer (50 to 100 µm)
Process developed by ACB in the past decade
- Action of punch and die
- Cycle time ≈ 30 min
- Very thin $\alpha$-case layer (5 to 15 $\mu$m)
- Homogeneous thickness
- No springback
Case study of a double-curvature part or deep drawn parts

- 10 years ago SPF to avoid wrinkles BUT thickness heterogeneity
- long cycle time
- thick α-case layer

Hot Forming adapted to double-curvature and deep drawn parts

Forming temperature: 650 – 730°C
Cycle time ≈ 30min (heating time included)
Forming process adapted to thick titanium profile
- From titanium extrusion parts
- No springback
- Reduced machining after forming → preform

Reduced buy-to-fly ratio

Serial production on Aries Manufacturing plant in Monroe (North Carolina – USA)
Linear Friction Welding

Considered as additive manufacturing process

• Mass production for engine parts manufacturing: Blisk
• Qualification for structural part in progress
Future is on-going...

HF / SPF combination

HSF / LFW combination
Future is on-going...
Conclusion

Increasing demand on titanium parts

Complex shape part due to customer’s design office requirements

Hot Forming technologies fit current and coming requirements
  • Quality / Tolerances
  • Microstructure / mechanical properties
  • Buy-to-fly
  • Increasing production cadency

Hot Forming technologies are still evolving
  • Process
  • Machines
Thank you for your attention