A NEW APPROACH
To
TITANIUM POWDER MADE PARTS
The MMS-Scanpac® Process

• The process was already described at the Chicago ITA Conference in 2014

• It is a combination of 2 key factors:
  – An agglomeration process involving a light binder (1 to 2%) easy to be removed before sintering
  – An adiabatic compaction which allows to reach almost full density on the finished parts

• It allows to utilize clean spherical powder.
Process sheet

Production routes Scanpac™/MMS

Raw powder
(Sintered powder from supplier)

Agglomeration
(Reconstituted)

Conventional press

HVC press
(Hydripelletizer machine)

CIF press

Sintering low temp.
(Alg. press)

Sintering high temp.
(Alg. press)

Blue route=MMS

HVC
(Hydripelletizer machine)

Sintering high temp.
(Alg. press)

HIP
(Alg. press)

Finished part / blank
All grades
(Pet zoetry / light intermetal)

Finished part / blank
All grades
(Pet zoetry / light intermetal)
Progress made in 2 years

- Introduction for step 1 of Multi effect hydraulic presses allows to manufacture multi-level parts (instead of purely prismatic parts)
Those parts are produced industrially

- For medium or large series at a rate of 10 parts per minute

- Properties are suitable for pressure vessels applications

- Actual production is for alloyed or stainless steel

- Applications range from the automotive industry to medical applications as well as for commodity products

- The process competes favorably with conventional metallurgy because of the yield (50% less scrap) and energy savings (up to 10kWh/kg)
R&D is going on for Titanium

- Various metals have been or are being tested:
  - Bronze
  - Aluminum (with SiC particles to reinforce the metal base)
  - Tool steel mixed with tungsten carbide (industrial production)

- Different types of titanium powder have been tested:
  - HDH powder
  - Chemically reduced powder
  - Gas atomized
  - Rotating electrode powder.
Experimental results

- Tests were performed in Grade 2 and Grade 5 for pucks and for gears

- HDH or chemically reduced powder is easy to compact but results in a high oxygen content. Densities of 98% were obtained after vacuum sintering without HIP

- Gas atomized or rotating electrode powder can only be compacted when using the full MMS-Scanpac process (including the specific binder)
- Cleanliness is better and densities have reached 99.5%
Experimental results

Grade 5 gear
  Diameter 48mm
  Height 10mm

The process involves
  High velocity adiabatic compaction
  Vacuum sintering (2h) at 1260°C
Size range achievable

- Due to the difficulty to handle clean spherical powder, there was no solution, up to now, medium range parts (from 100g to 10kg)

- Large parts can be HIPped in closed containers, homothetic to the final part shape (the container has to be removed by grinding or pickling after HIPping, which limits the competitiveness.

- Small parts are easily manufactured by MIM: titanium powder is then mixed with a plastic binder which needs to be evacuated before sintering which limits the size of the parts.

- The MMS-Scanpac® brings a solution for this medium range: from 50g to 5kg (can be increased to 10 or more with a bigger press)
Complementarity with other processes considering the parts to be produced

a) Part size
   - Small parts (<100g): MIM
   - Medium parts (50g-5 kg+): MMS-Scanpac®
   - Big parts (>5kg): HIP

b) Series
   - Medium or large series: MIM--HIP--MMS-Scanpac®
   - Small series: 3-D printing
Complementarity with other processes considering powder utilization

Each process utilizing powder (for parts or for coating in the case of stainless steel and nickel alloys*) requires a different size range:

- **MIM**: < 20 µ
- **HVOF***: 22-53 µ
- **3-D printing**: 53-88 µ
- **Flame Spray***: 22-88 µ
- **PTA***: 88-150 µ
- **MMS-Scanpac**: 50-250 µ
- **HIP**: 150-500 µ
Powder production follows a Gaussian distribution
Which can be harmoniously distributed to all usages

Producing very fine powder requires sophisticated nozzles and high cooling energy which limits practically the grain size.

To reduce this grain size and obtain a narrower range, plasma treatment can help to reduce the grain size.

But more and more energy is required for smaller sizes
It looks wiser to find a utilization for each fraction of the distribution in order to avoid expensive recycling.

This requires an adequate sieving of the powder and a good monitoring of the marketing plan in order to correspond to the volumes of each fraction in the Gauss curve
Powder production follows a Gaussian distribution
Which can be harmoniously distributed to all usages
A way to decrease powder cost and boost 3-D printing

MMS-Scanpac brings (on top of HIP) an additional segment to consume powder in excess of 88µ. MIM will consume the fines. Therefore an adequate sieving allows to utilize whatever quantity is not usable for 3-D printing.

With that possibility, 3-D printing can develop in an economical way, because it is much less costly to sieve than to plasma treat the powder.