



Titanium Grade 5

Report ID: RD/RM/1001

Material: Titan Grade 5

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Introduction

The goal of this report is a short summary of Titan Grade 5 atomization status for marketing purposes.

There were multiple test performed on Titan Grade 5. The atomized material was in the form of a \varnothing 1,6 mm wire.

For each test, microscopic analysis of the distribution, circularity, oxygen level, chemical composition and flowability test were performed.

Average test results

Table 1 Basic average values

| | Diameter [μm] | Circularity |
|--------------------|----------------------------|-------------|
| Average | 55,94 | 1,00 |
| Standard deviation | 12,42 | 0,03 |
| Max | 123,21 | 1,00 |
| Min | 27,82 | 0,75 |

Figure 1 Photo of the material x100

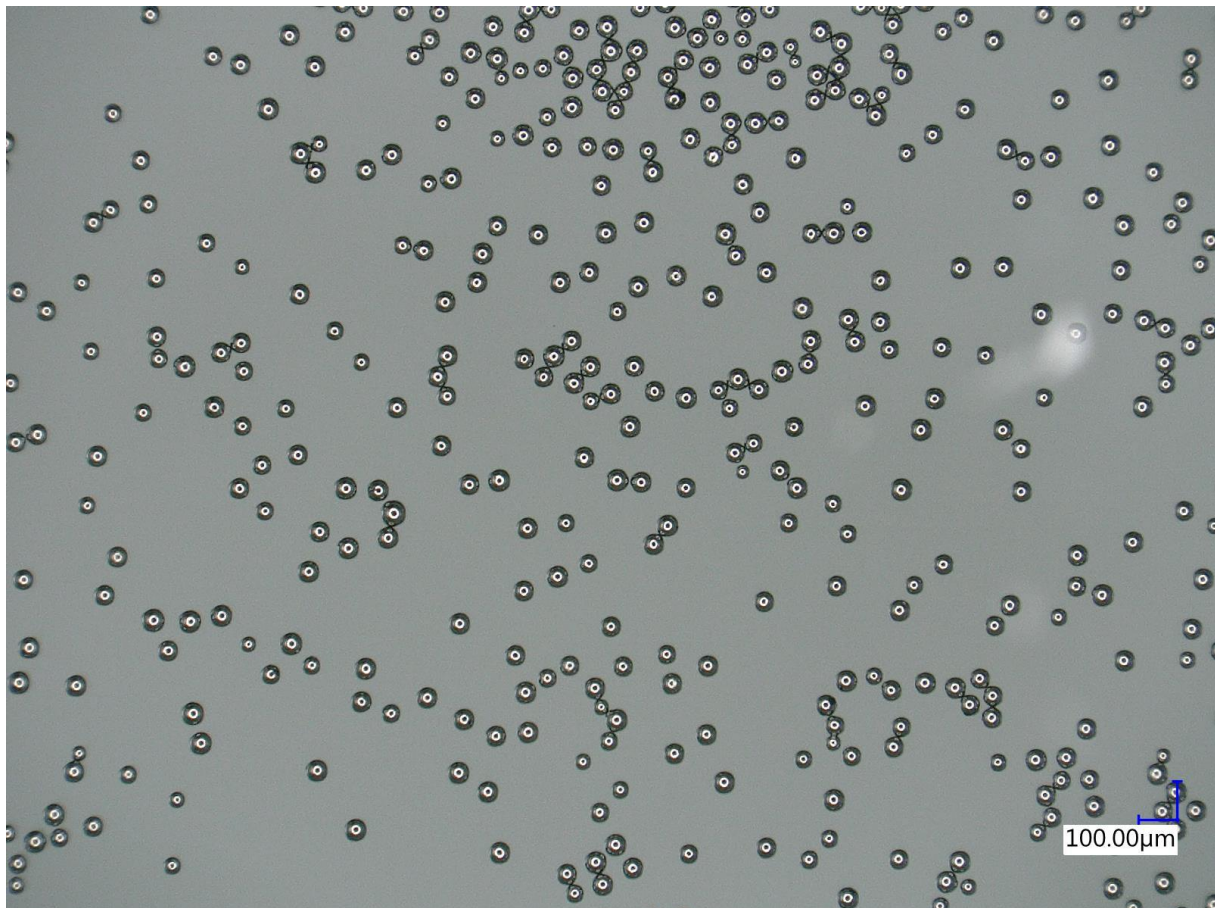


Figure 2 Histogram of the particle size distribution

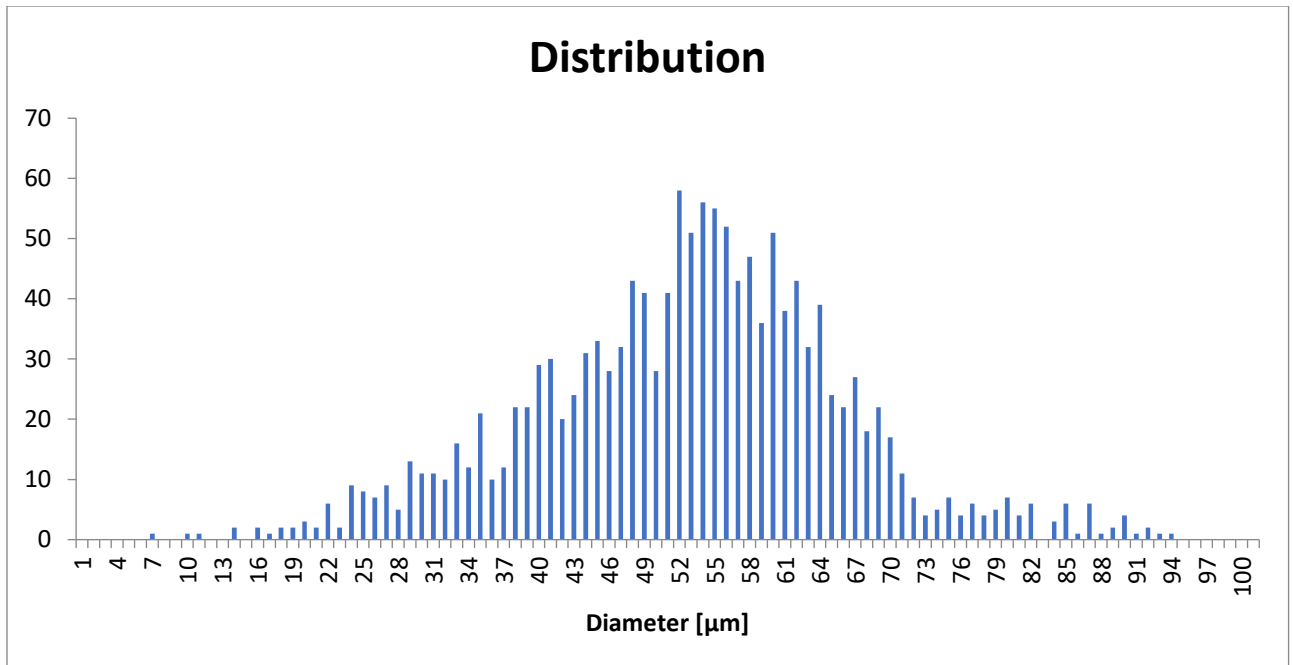


Table 2 Particles size distribution D10, D50, D90

| | | | | | |
|-----|-------|-----|-------|-----|-------|
| D10 | 37,24 | D50 | 48,87 | D90 | 71,54 |
|-----|-------|-----|-------|-----|-------|

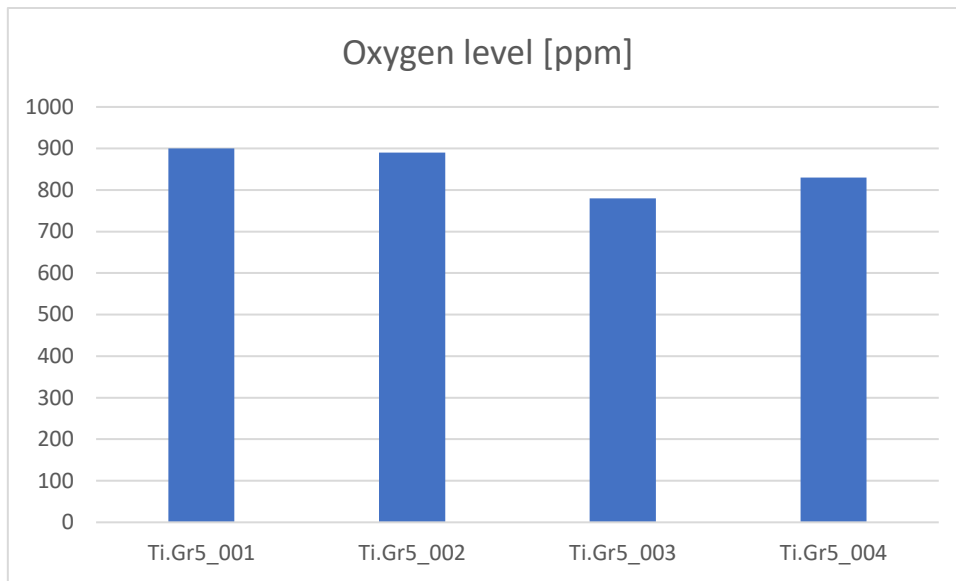
Oxygen level

Oxygen level have been tested in a certified laboratory. The results are shown below.

Table 3 Oxygen level in the samples

| Sample | Test results [%] | U _B | Test methods |
|------------|------------------|----------------|-------------------------|
| Ti.Gr5_001 | 0.090 | 0.002 | <i>LECO methodology</i> |
| Ti.Gr5_002 | 0.089 | 0.002 | |
| Ti.Gr5_003 | 0.078 | 0.002 | |
| Ti.Gr5_004 | 0.083 | 0.002 | |

Figure 3 Oxygen level in the samples



Chemical composition

The chemical composition was checked in certified laboratory. Test were performed by ICP-OES method.

Table 4 Chemical composition of nickel powder and nickel wire #

| Requirements for Ti6Al4V grade [%] | | Titanium powder | $U_B^{(1)}$ | Titanium wire | $U_B^{(1)}$ | Test methods |
|------------------------------------|---------------|-----------------|-------------|---------------|-------------|----------------------|
| Test results [%] | | | | | | |
| Al | 5.50 ... 6.75 | 6.0 | 0.4 | 6.6 | 0.5 | BOSMAL/I-7-43/06 |
| V | 3.50 ... 4.50 | 4.0 | 0.3 | 4.0 | 0.3 | |
| Fe | ≤ 0.40 | 0.28 | 0.02 | 0.21 | 0.02 | |
| C | ≤ 0.08 | 0.025 | 0.002 | 0.022 | 0.002 | PN-EN ISO 15350:2010 |
| N | ≤ 0.05 | < 0.005 | - | < 0.005 | - | PN-EN ISO 10720:2009 |
| H | ≤ 0.015 | 0.0047 | 0.0005 | 0.0053 | 0.0005 | LECO methodology |
| O | ≤ 0.20 | 0.0039 | 0.0004 | 0.0036 | 0.0004 | |
| Cu | - | 0.036 | 0.003 | < 0.01 | - | BOSMAL/I-7-43/06 |
| W | - | < 0.05 | - | < 0.05 | - | |
| Ti | balance | balance | - | balance | - | |

⁽¹⁾ U_B – total expanded uncertainty of category B (confidence level 0.95)

Flowability

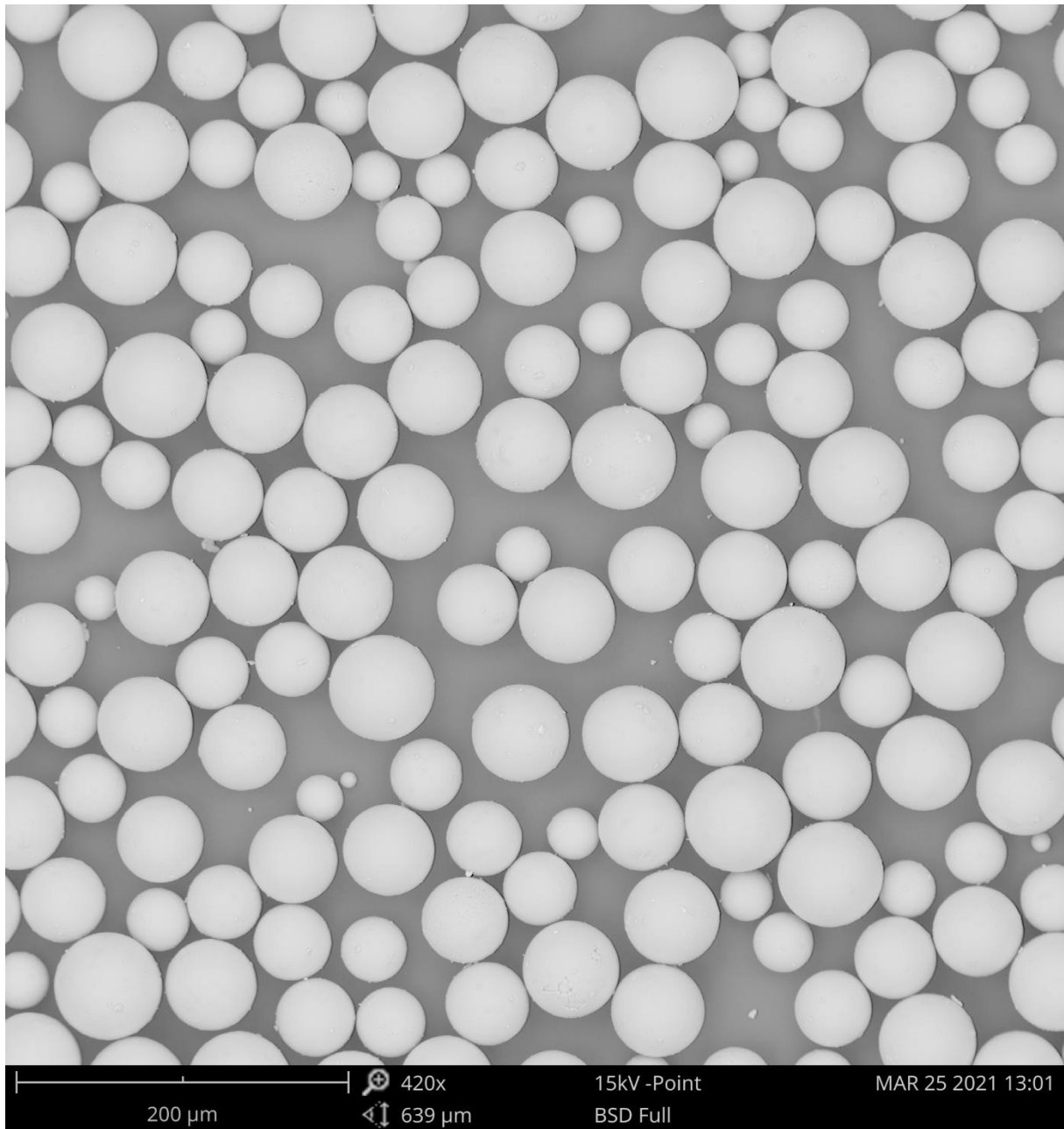
Flowability was checked with Hall flowmeter (ISO 4490)

Table 3 Flowability mesurment result

| No | Sample | Flow time [s] |
|----|--------|---------------|
| 1 | Ti.Gr5 | 27,9 |

SEM

Figure 4 SEM photo of Titanium Grade 5



Overall Conclusion

For Titan Grade 5 average measured particle diameter was 57 μm . Particles have good sphericity without any defects. c. Process of atomization of the Titan Grade 5 was very stable and predictable. Process efficiency oscillated around 94% and 0,5 kg/h.