# Technical Bulletin

Tungsten Carbide – 12% Cobalt
Tungsten Carbide – 17% Cobalt

## The right choice for high hardness and excellent wear resistance

### Introduction

Tungsten Carbide (WC) based thermal spray powders are applied in various applications to provide optimal surface protection against abrasion, friction wear, erosion, or cavitation. Depending on the ambient conditions, the coatings can be used at moderate temperature levels up to a maximum of 500 °C.

The Carbide content, primary carbide size, and matrix composition define key properties of the coatings, including wear resistance and mechanical properties. Therefore, proper material selection is crucial for achieving the best possible performance of the coating in the targeted application.

Tungsten Carbide powders with a matrix of pure Cobalt (WC-Co) are the best choice for protection against abrasion, fretting, sliding wear, or impact in many industrial applications, as well as in non-corrosive environments in Aviation. Application in acidic environments cannot be recommended.

For better corrosion resistance at comparable wear resistance, powders such as WC 10Co 4Cr or WC 20CrC 7Ni or WC 42CrC 16Ni should be applied.

### Powder Properties and Typical Applications

Höganäs' carbide portfolio includes various grades of agglomerated & sintered as well as sintered & crushed WC-Co powders, each with different Cobalt contents and carbide sizes (Figure 1).

Powders with 12% Cobalt, such as **Amperit 518** and **519**, are the right choice for applications that require high hardness and excellent wear resistance. With its higher apparent density and tuned particle morphology, **Amperit 519** has been optimized for liquid-fueled HVOF systems (Figure 2).

Sintered & crushed **Amperit 515** contains very coarse carbides (> 5 µm) and has been specially developed for plasma spraying in aviation applications. Additionally, **Amperit 515** can be used in applications where very rough surfaces are needed, such as guide rolls or winding drums in the paper industry.

Due to its higher Cobalt content of 17%, coatings produced from **Amperit 526** exhibit higher stress tolerance and impact resistance compared to coatings made of WC 12Co.

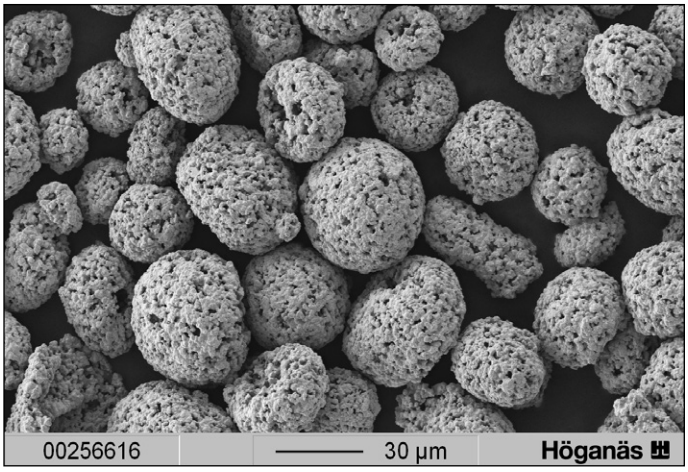
Due to its low carbon content and special production route, **Amperit 512** does not contain metallic Cobalt. The well-defined phase composition of WC, $W_2C$, and eta-phase has been optimized to resist the attack of liquid metal and reduce dross buildup on sink rolls and stabilizer rolls ensuring an optimum surface quality of the steel strip in Continuous Galvanizing Lines. Generally, these HVOF-sprayed coatings are post-treated with a sealant.

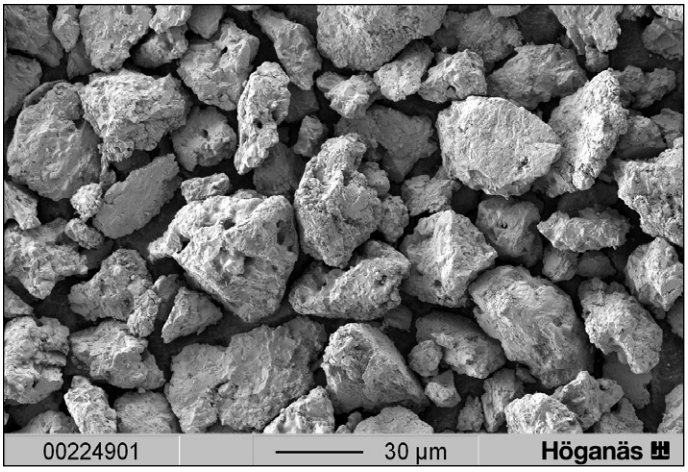
The primary particle size strongly influences the hardness and wear resistance of the coatings. Finer carbide particles result in higher hardness of the coating, thereby improving its resistance against sliding wear. In applications involving particle erosion and cavitational attack, materials containing coarser primary carbide particles perform better.

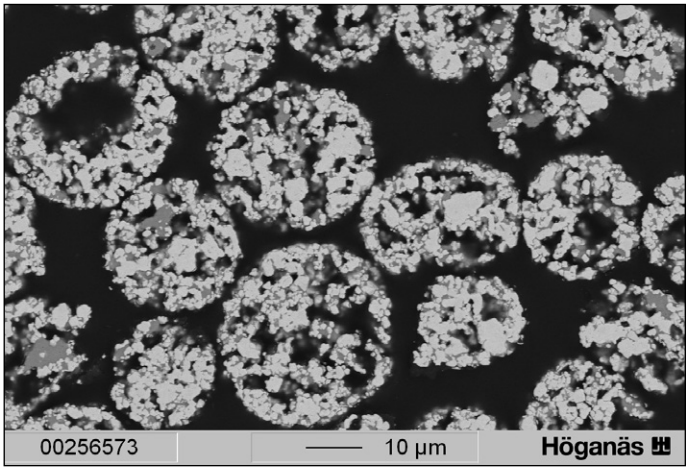
| Typical Properties of HVOF- and HVAF-Sprayed Coatings | | |
|---|---|---|
| Deposition Efficiency: | 40–65% | |
| Roughness as-sprayed, Ra: | 3.0–7.0 µm, 2.5 µm or below achievable, using fine powders such as 30/5 µm | |
| Bond Strength (on steel): | > 70 MPa | |
| Hardness HV0.3: | **WC 12Co** | 1000–1400 (APS 750–1200) |
| | **WC 17Co** | 900–1300 |
| Wear (ASTM G65, mod): | **WC 12Co** | < 5 $mm^3$ |
| | **WC 17Co** | < 8 $mm^3$ |

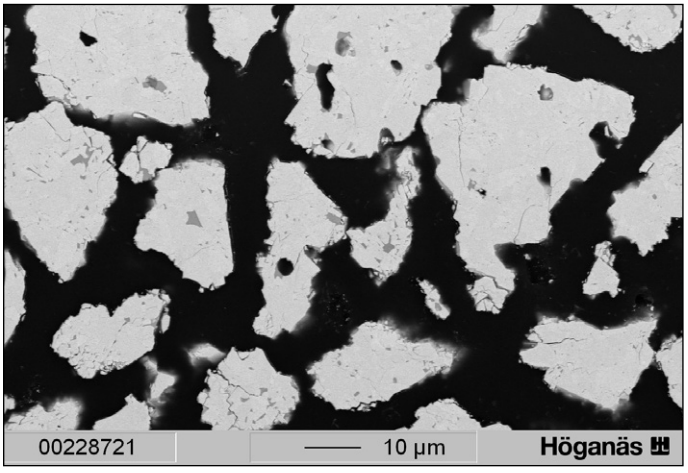
**Typical data. For more details, please contact us at: www.hoganas.com/en/contact/*

## Figure 1: Typical Powder Morphology



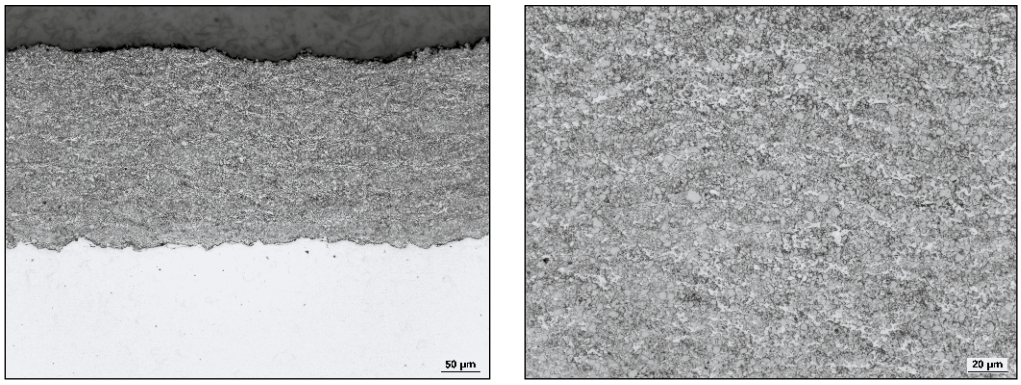



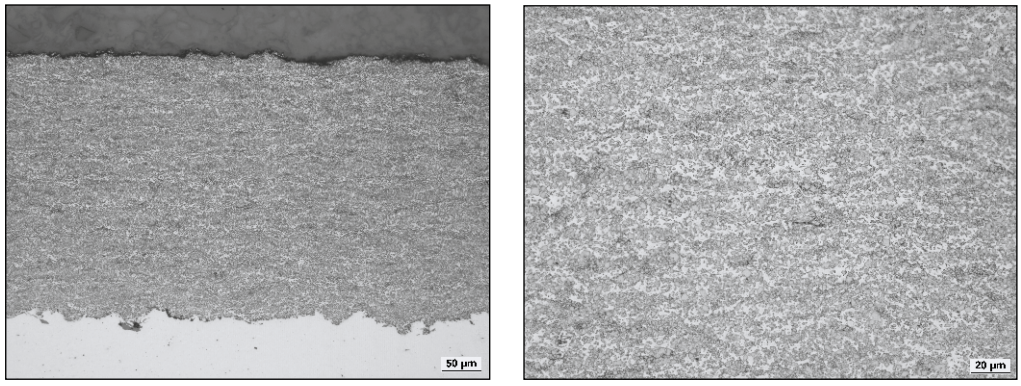

**Amperit 518**
Agglomerated & Sintered, predominantly spherical particle shape

**Amperit 515**
Sintered & Crushed, blocky and dense particles

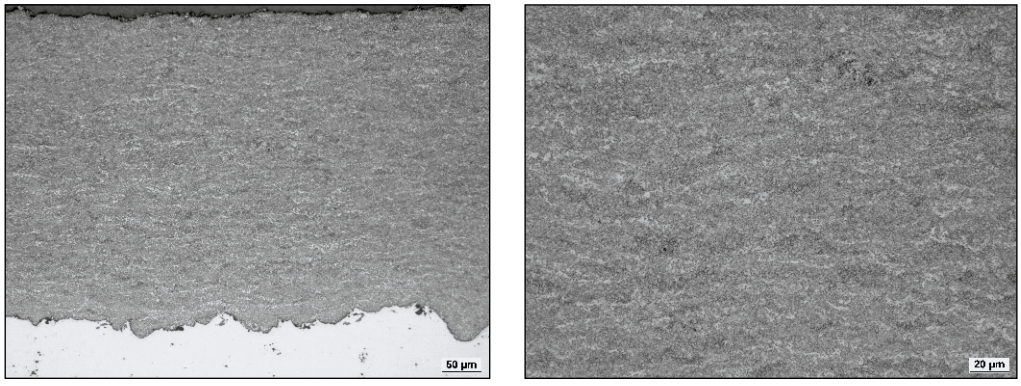
## Figure 2: Microstructures (LOM) of Typical Coatings



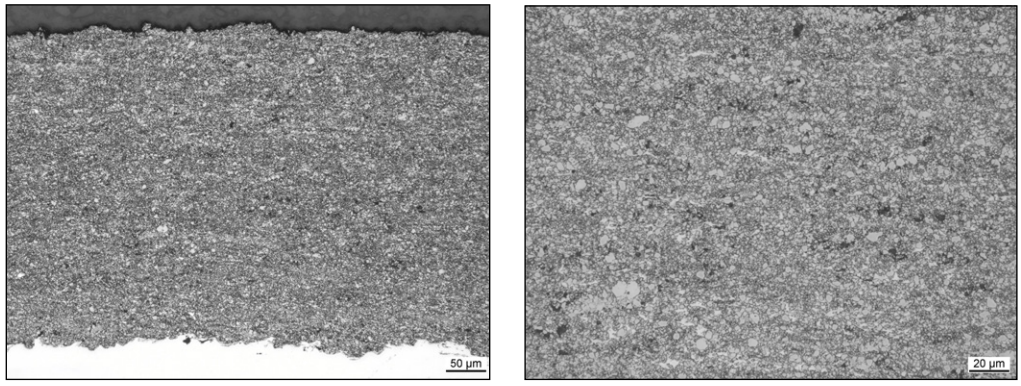

**Amperit 512.074** - Sprayed with liquid-fueled HVOF




**Amperit 518.059** - Sprayed with liquid-fueled HVOF




**Amperit 519.059** - Sprayed with liquid-fueled HVOF




**Amperit 526.074** - Sprayed with liquid-fueled HVOF

| Amperit | Particle Size (µm) | Carbide Size | APS | HVOF | HVAF | Special Features and Typical Applications |
|---|---|---|---|---|---|---|
| **WC 12Co, Agglomerated & Sintered:** | | | | | | |
| **512.059** | 30/5 | Coarse | | X | X | • Low C content: 3.6–4.1%<br>• No metallic Cobalt<br>• Resistance against liquid Zn-based alloys<br>• Specially developed for Zn bath rolls in Continuous Galvanizing Lines (CGL)<br>• Typically applied with a sealer<br>• Alternate material: Amperit 538, WC 30WB 10Co |
| **512.074** | 45/15 | | X | X | | |
| **512.088** | 53/20 | | X | X | | |
| **518.001** | 45/22 | Medium | X | X | | • Hard, dense coatings with good abrasion, erosion, and sliding wear resistance<br>• Smooth coatings with fine microstructure and high bond strengths<br>• General industry, oil & gas, process rolls in steel production, paper rolls, corrugated rolls, wire drawing equipment, pump seals and housing, machine parts, etc.<br>• Aviation: fan and compressor blades |
| **518.002** | 90/45 | | X | X | | |
| **518.054** | 45/10 | | | X | | |
| **518.059** | 30/5 | | | X | X | |
| **518.074** | 45/15 | | | X | | |
| **519.059** | 30/5 | Fine | | X | X | • Optimized for liquid-fueled HVOF<br>• Dense coatings with good stress tolerance and cavitation resistance<br>• Better surface quality achievable after surface finish<br>• Paper: process rolls, corrugated rolls<br>• Aviation: landing gears, actuators<br>• Hydropower: hydro turbine runners, Pelton buckets<br>• Oil & Gas: high-pressure valves in submarine exploration<br>• Hard chrome replacement |
| **519.074** | 45/15 | | | X | | |
| **528.764** | --- | --- | | | | • GE B50TF295, see Amperit 518 |
| **WC 12 Co, Dense Sintered & Crushed:** | | | | | | |
| **515.001** | 45/22 | Very Coarse | X | X | | • Low C content: 3.9–4.3%<br>• Blocky and dense particles<br>• Hard, dense coatings with good abrasion, erosion, and sliding wear resistance<br>• Coatings with high surface roughness<br>• Aviation: flap tracks, compressor air seals, fan blade mid-span supports, etc.<br>• General industry: winder and guide rolls in paper making, machine parts, etc. |
| **515.002** | 90/45 | | X | | | |
| **515.074** | 45/15 | | X | X | | |
| **WC 17Co, Agglomerated & Sintered:** | | | | | | |
| **526.059** | 30/5 | Coarse | | X | X | • Higher ductility than WC 12Co due to higher Co content<br>• Hard, dense coatings with good sliding wear and fretting resistance, as well as impact tolerance<br>• Aviation: flap tracks, compressor air seals, fan blade mid-span supports, landing gear, etc.<br>• General industry: extrusion dies, glass industry, paper mill rolls, pump parts, wire drawing equipment, etc. |
| **526.062** | 53/10 | | X | X | | |
| **526.074** | 45/15 | | | X | | |
| **526.077** | 63/32 | | X | | | |
| **526.088** | 53/20 | | X | X | | |

## OEM Approvals

| OEM | Specification | Amperit |
|---|---|---|
| **Boeing** | BMS 10-67 Type I | Amperit 515.830 |
| | BMS 10-67 Type I | Amperit 526.831 |
| **Bombardier** | BAMS 561-001 Rev.A Type 1 | Amperit 526.784 |
| **De Haviland** | DHMS C4.19 | Amperit 526.781 |
| **GE Aviation** | GE B50TF27 CLASS A | Amperit 518.280 |
| | GE B50TF27 CLASS B | Amperit 518.768 |
| | GE B50TF295 CLASS A | Amperit 528.764 |
| **GKN** | PM 819-01 | Amperit 515.851 |
| | PM 819-53 | Amperit 515.851 |
| | PM 819-25 | Amperit 518.874 |
| **McDonnel Douglas** | DMS 2049 Type 2 | Amperit 515.949 |
| | DMS 2049 Type 5 | Amperit 526.895 |
| **MTU** | MTS 1055 | Amperit 515.203 |
| | MTS 1058 | Amperit 526.223 |
| **PWA** | PWA 36331-1 | Amperit 526.454 |
| **Rolls Royce** | RRMS 40032 | Amperit 526.350 |
| | RRMS 40015 | Amperit 526.382 |
| **SAE (AMS)** | AMS 7879 Class 2 | Amperit 515.400 |
| | AMS 7881 Method 1+2 | Amperit 526.437 |
| **SAFRAN** | DMR 33-501 | Amperit 526.727 |
| | DMR 33-019 | Amperit 526.729 |

## Related Products

- WC with a CoCr metal matrix material provide significantly better corrosion protection compared to WC-Co coatings, although the hardness and wear resistance of WC-Co coatings are, in most cases, higher. Product series include Amperit 507, 554, 556, 557, 558 and 658.
- WC-Ni materials, Amperit 547, are a suitable option for applications that require cobalt-free wear protection coatings. The wear resistance is slightly lower compared to WC-Co and WC-CoCr.
- The WC-CrC-Ni materials Amperit 543, 551 and 555 are suitable for service temperatures up to 750 °C and offer better corrosion protection in comparison to WC-Co coatings.
- Materials based on chromium carbides, such as Amperit 578, 584, 585 and 588, allow service temperatures up to 870 °C and offer superior corrosion and cavitation protection. However, their wear resistance and hardness are lower in comparison to the WC-Co materials.
- Amperit 538.074 (WC 30WB 10Co) is designed for special applications such as Zn-bath equipment, Aluminizing, or other applications involving liquid metal contact.
- Amperit 618.074 (WC 15FeCrAl) is a Co- and Ni-free alternative for wear protection coatings.
- Nickel self-fluxing alloys with the addition of hard phases are widely used for hard facing applications. The coatings are mainly applied by flame spraying, followed by a subsequent fusing treatment.
- Nickel self-fluxing alloys applied by HVOF reach hardness levels of 400–600 HV0.3, making them suitable for moderate wear applications offering good corrosion protection.
- Iron-based alloys such as 3.50 and 3650-02 can be applied by HVOF and offer moderate wear protection and good corrosion resistance at hardness values in the range of 400–600 HV0.3. Amperit 381-type and Rockit 401 are corrosion-resistant materials suitable for laser cladding and PTA reaching hardness values at around 55 HRC.

## Handling and Safety Recommendations

- Store in dry location.
- Open containers should be stored in a drying oven to prevent moisture pickup.
- Tumble powder prior to use to prevent segregation.
- For information related to health, safety and the environment, please refer to the respective Safety Data Sheets.

**More info: scan or click the QR Code**

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