

# Material Product Data Sheet

## Nickel [Cobalt] Chromium Aluminum Yttrium (Ni[Co]CrAl[Mo, Ta, HfSi]Y) Powders

### Powder Products:

**Amdry™ 962 series, Amdry 963, Amdry 964,  
Metco™ 2253A, Amdry 365 series, Amdry 386  
series, Amdry 997, SPM4-2667**

### 1 Introduction

NiCrAlY and NiCoCrAlY alloys are thermal spray coating materials that are known for their excellent resistance to oxidation and hot corrosion. Coatings of these materials are used as bond coats for ceramic top coats or by themselves to resist corrosion at temperatures up to 980 °C (1800 °F) if applied using atmospheric plasma spray (APS), or up to 1050 °C (1920 °F) if applied using HVOF or ChamPro™ controlled atmosphere plasma spray (LPPS™, LVPS™ or VPS).

Chromium and aluminum in these coatings provide protection through the formation of a continually replenishing oxide scale. The addition of yttrium acts to improve the adhesion of this oxide layer. This dense, well-adherent scale is critical for the prolonged life of high temperature ceramic coating systems such as thermal barrier coatings and ceramic abrasible systems. The alumina acts as an oxygen diffusion barrier that helps to delay bond coat oxidation.

The chromium oxide scale is beneficial to combat hot corrosion and sulfidation. In these applications, higher chromium to aluminum ratios are favorable for chromium oxide scale formation.

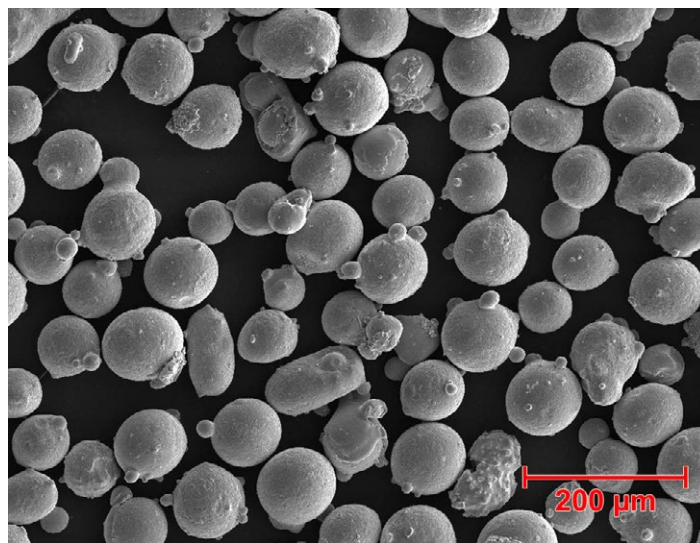
The presence of cobalt in NiCoCrAlY alloys improves coating ductility and hot corrosion resistance. Hafnium in the Amdry 386 series products increases the adhesion of the thermally-grown oxide layer. The addition of tantalum in Amdry 997 provides superior oxidation resistance at high temperatures. Molybdenum and tantalum in Metco 2253A benefits thermal cycling life and sulfidation resistance.

These products can be used as overlay coatings on turbine engine components to improve their performance and service life, even under harsh environmental conditions.

Gas atomization ensures excellent chemical homogeneity and high purity which results in consistent coating results.

### Quick Facts

Classification	Alloy, nickel-based
Chemistry	NiCrAlY or NiCoCrAl[Mo, Ta, HfSi]Y
Manufacture	Gas atomization
Morphology	Spheroidal
Purpose	Oxidation and hot corrosion resistance
Service Temperature	
APS	≤ 980 °C (1800 °F)
HVOF or ChamPro	≤ 1050 °C (1920 °F)
Process	Atmospheric plasma spray, HVOF or ChamPro™



SEM photomicrograph of Amdry 962 showing the powder exterior morphology typical of these gas atomized products.

### 1.1 Typical Uses and Applications

- Bond coat for thermal barrier and ceramic abrasible applications
- Coatings applied to alloys of iron-, nickel- or cobalt-based substrates to minimize oxidation and extend life at higher temperatures
- Resist oxidation and hot corrosion on aerospace and industrial gas turbine hot-section components, such as turbine buckets, blades, vanes, shrouds and combustors.
- Repair and restoration of superalloy substrates and parts
- Protect heat-treating fixtures
- Protect exhaust manifolds and ducts

## 2 Material Information

### 2.1 Chemical Composition

Product	Chemical Composition (wt. %)										
	Ni	Co	Cr	Al	Mo	Ta	Y	C	Hf	Si	Other
Amdry 962	Bal.	---	21.0–23.0	9.0–11.0	---	---	0.8–1.2	---	---	---	< 1.0
Amdry 9621	Bal.	---	21.0–23.0	9.0–11.0	---	---	0.8–1.2	---	---	---	< 1.0
Amdry 9624	Bal.	---	21.0–23.0	9.0–11.0	---	---	0.8–1.2	---	---	---	< 1.0
Amdry 9625	Bal.	---	21.0–23.0	9.0–11.0	---	---	0.8–1.2	---	---	---	< 1.0
Amdry 963	Bal.	---	24.0–25.0	5.0–7.0	---	---	0.3–0.5	---	---	---	< 1.0
Amdry 964	Bal.	---	30.0–32.0	10.0–12.5	---	---	0.4–0.9	---	---	---	< 1.0
Metco 2253A	Bal.	---	22.0–28.0	5.0–11.0	3.0–7.0	3.0–7.0	0.1–0.8	0.5–1.3	---	0.4–1.2	≤ 1.0
Amdry 365-1	Bal.	20.0–26.0	14.0–20.0	11.0–14.0	---	---	0.1–0.8	---	---	---	≤ 1.0
Amdry 365-2	Bal.	20.0–26.0	14.0–20.0	11.0–14.0	---	---	0.1–0.8	---	---	---	≤ 1.0
Amdry 365-4	Bal.	20.0–26.0	14.0–20.0	11.0–14.0	---	---	0.1–0.8	---	---	---	≤ 1.0
Amdry 386	Bal.	19.0–26.0	14.0–21.0	11.0–14.0	---	---	0.2–0.8	---	0.1–0.5	0.1–0.7	≤ 1.0
Amdry 386-2	Bal.	19.0–26.0	14.0–21.0	11.0–14.0	---	---	0.2–0.8	---	0.1–0.5	0.1–0.7	≤ 1.0
Amdry 386-2.5	Bal.	19.0–26.0	14.0–21.0	11.0–14.0	---	---	0.2–0.8	---	0.1–0.5	0.1–0.7	≤ 1.0
Amdry 386-3	Bal.	19.0–26.0	14.0–21.0	11.0–14.0	---	---	0.2–0.8	---	0.1–0.5	0.1–0.7	≤ 1.0
Amdry 386-4	Bal.	19.0–26.0	14.0–21.0	11.0–14.0	---	---	0.2–0.8	---	0.1–0.5	0.1–0.7	≤ 1.0
Amdry 997	Bal.	20.0–26.0	18.0–23.0	6.0–11.0	---	2.0–6.0	0.3–0.9	---	---	---	N.R.
SPM4-2667	Bal.	19.0–26.0	14.0–21.0	11.0–14.0	---	---	0.2–0.8	---	0.1–0.5	0.1–0.7	≤ 1.0

N.R. = not reported

### 2.2 Particle Size Distribution

Product	Nominal Particle Size Distribution (µm)	Manufacturing Method	Morphology
Amdry 962	-106 +53	Gas Atomized	Spheroidal
Amdry 9621	-90 +45	Gas Atomized	Spheroidal
Amdry 9624	-37 +11	Gas Atomized	Spheroidal
Amdry 9625	-74 +45	Gas Atomized	Spheroidal
Amdry 963	-90 +45	Gas Atomized	Spheroidal
Amdry 964	-106 +37	Gas Atomized	Spheroidal
Metco 2253A	-45 +11	Gas Atomized	Spheroidal
Amdry 365-1	-45 +5	Gas Atomized	Spheroidal
Amdry 365-2	-75 +38	Gas Atomized	Spheroidal
Amdry 365-4	-45 +20	Gas Atomized	Spheroidal
Amdry 386	-63 +5	Gas Atomized	Spheroidal
Amdry 386-2	-88 +16 *	Gas Atomized	Spheroidal
Amdry 386-2.5	-63 +22 *	Gas Atomized	Spheroidal
Amdry 386-3	-125 +53	Gas Atomized	Spheroidal
Amdry 386-4	-90 +38	Gas Atomized	Spheroidal
Amdry 997	-38 +5	Gas Atomized	Spheroidal
SPM4-2667	-88 +38	Gas Atomized	Spheroidal

Upper particle size analysis by screen analysis; lower particle size analysis by laser diffraction (Microtrac); except as noted.

\* Upper and lower particle size analysis by laser diffraction (Microtrac)

Other particle size distributions are available on request.

## 2.3 Key Selection Criteria

- Choose the material best suited for the spray process to be used (please refer to Section 2.5) and the service environment.
- In many cases, the requirement to meet a specific customer/OEM specification will dictate which material should be used (see Section 2.6).
- Metco 2253A is a recently developed NiCrAlMoTaSiYC material that produces coatings that exhibit significant improvement in thermal cycling as a result of its much lower coefficient of thermal expansion and sulfidation-based hot-corrosion resistance.
- Amdry 962 and the Amdry 962x family of materials have a general-purpose chemistry that is used for many applications requiring high-temperature oxidation resistance.
- Amdry 963 has lower aluminum and higher chromium content that may be better suited to service environments where hot corrosion or sulfidation is an issue.
- Amdry 964 has higher chromium and aluminum content in the nickel matrix and may see longer service life, depending on the environment and/or the composition of the substrate. HVOF cuts are available on a custom-order basis.
- Amdry 997 is a premium grade NiCoCrAlTaY gas atomized powder that produces coatings having excellent resistance against oxidation and hot corrosion at high temperatures. The addition of tantalum significantly enhances the coating's high temperature oxidation resistance.
- The use of ChamPro processes (LVPS, LPPS and VPS) with suitable cuts of the materials (see Section 2.5) produce superior low oxide coatings that machine well and closely resemble wrought alloys in their characteristics.
- Amdry 386 series and SPM4-2667 provide better adhesion between coating layers when a suitable particle size distribution is chosen for the spray process used.

## 2.5 Recommended Spray Process and Spray Guns

Product	Atmospheric Plasma Spray	HVOF	ChamPro (LVPS™, LPPS™, VPS)
Amdry 962	●		
Amdry 9621	●		
Amdry 9624		●	●
Amdry 9625	●		
Amdry 963	●		
Amdry 964	●	a	
Metco 2253A	●	●	●
Amdry 365-1		●	●
Amdry 365-2	●		
Amdry 365-4		●	
Amdry 386			●
Amdry 386-2	●	●	
Amdry 386-2.5		●	
Amdry 386-3	●		
Amdry 386-4	●		
Amdry 997		●	●
SPM4-2667	●		

<sup>a</sup> An HVOF cut of Amdry 964 is available on a custom order basis

## 2.4 Related Products

- Oerlikon Metco also offers CoCrAlY and CoNiCrAlY products. The benefit of these materials are chemistries that produce coatings with a balanced combination of high temperature oxidation resistance and hot corrosion resistance.
- For bond coat and salvage and repair applications at service temperatures below 980 °C (1800 °F) an MCrAlY material may not be required and a nickel aluminum, nickel chromium aluminum or nickel chromium material could be considered. .
- Alternative choices for lower temperature salvage applications may be coating materials similar to Hastelloy, Inconel or Tribaloy. Coatings of these materials are typically harder and more wear resistant than MCrAlY materials; however, coatings of Metco 2253A show higher wear resistance compared to standard MCrAlY coatings.
- Other proprietary MCrAlY materials supplied by Oerlikon Metco are customer-specific and supplied to OEM-qualified users. Please refer to the datasheet for Proprietary MCrAlYs.
- For qualifying volumes, Oerlikon Metco is capable of developing and producing unique customized MCrAlY chemistries and particle size distributions to meet specific requirements. Please contact your Oerlikon Metco Account Representative for further information.
- Oerlikon Metco offers a substantial portfolio of thermal barrier ceramic products that meet various requirements and customer specifications for which these NiCrAlY and NiCoCrAlY materials are often used as a bond coat. .
- These NiCrAlY and NiCoCrAlY materials are also used as bond coats with Oerlikon Metco's high temperature, ceramic abradable materials.

## 2.6 Customer Specifications

<b>Product</b>	<b>Customer Specifications</b>
Amdry 962	CFM International CP 6023 Chromalloy BZ 003 Type 53 GE B50A892 GE B50TF162 GE B50TF192, Class A GKN Aerospace PM 819-44 MTU MTS 1333 Snecma DMR 33.090 Turbomeca LA 657 Ed. 1, PD 2, Ind. 0 U. S. Military USAF 461204 (material only for bond coat)
Amdry 9621	GE B50AG16, Class A, except Section 4
Amdry 9625	Honeywell EMS 57737, Type II Honeywell M3960
Amdry 963	Rolls-Royce Corporation EMS 56719 Rolls-Royce Corporation PMI 1351 Rolls-Royce plc RRMS 40050
Amdry 964	Chromalloy BZ 003 Type 40 Honeywell 91547-52564 (Bond Coat) Honeywell EMS 52439, Class E Honeywell EMS 57737, Type 1 Light Helicopter LHM 3315
Amdry 365-1	Pratt & Whitney PWA 1365-1
Amdry 365-2	Avio 4800M/42 Canada Pratt & Whitney CPW 387 GKN Aerospace PM 819-51 Hamilton Sundstrand ESR 1488 Jet Avion JA 1365-2 Pratt & Whitney PWA 1365-2
Amdry 386	Pratt & Whitney PWA 1386-1 Chromalloy C-76 Howmet CD 1115
Amdry 386-2	Pratt & Whitney PWA 1386-2
Amdry 386-2.5	Pratt & Whitney PWA 1386 (chemistry only)
Amdry 386-3	Pratt & Whitney PWA 1384-2
Amdry 386-4	GKN Aerospace PM 819-88 Pratt & Whitney PWA 1384-1 Siemens MAT 870022 U. S. Military USAF 461206 (material only for bond coat)
Amdry 997	Turbomeca LA 657 PF1 Ind. 0
SPM4-2667	Chromalloy C-77

### 3 Coating Information

#### 3.1 Key Thermal Spray Coating Information

Please consult Oerlikon Metco Coatings Solutions Centers (CSC) when coating and application development support is required for NiCrAlY coatings. CSC has experience in optimizing spray parameters for specific customer needs. Types of support that CSC can provide include information on higher surface profile coatings, low oxide coatings, high density coatings, heat-treatment recommendations, material coverage, material deposition, and thickness limits.

#### 3.2 Post-Coating Heat Treatment

Post-coat heat treatment of NiCrAlY coatings homogenizes the deposit as well as diffusing the coating into the substrate, enhancing bond strength. Post-coat heat treatment also results in precipitation of intermetallic phases of Beta Ni-Al that act as reservoirs for the formation of thin, dense, protective alumina scales that enhances bonding between the top coat and the MCrAlY bond coat. In addition, the heat treatment relaxes the deposition stresses due to thermal spray processes.

The heat treatment procedure for a NiCrAlY coating depends on the substrate chosen and the OEM specification. If no heat treatment specification is defined, a diffusion heat treatment in a controlled atmosphere of 2 to 4 hours at 1080 to 1200 °C (1975 to 2200 °F) can be used as a starting point. A benefit of NiCrAlY coatings is their high percentage of aluminum content compared to that of the substrate material. Too high a concentration of aluminum in superalloy substrates results in brittle phases and reduced mechanical

strength. Since coatings are not structural by nature, they can have high levels of aluminum to promote Thermally Grown Oxide (TGO) development and maintenance of an aluminum reservoir in service.

Studies performed by Oerlikon Metco demonstrate that post-coat heat treatment in vacuum (0.5 mbar and 6.67 E-04 mbar) affects the characteristics of TGO (thermally grown oxides) and significantly improved TBC thermal cycling lifetime. The post-coat heat treatment in vacuum can generate a very thin, continuous and dense alumina layer with uniform thickness at the interface between the top coat and bond coat, which leads to a steady and uniform growth of alumina TGO thereafter when the TBC is exposed to a high temperature.

#### 3.3 Coating Parameters

Please contact your Oerlikon Metco Account Representative for parameter availability. For specific coating application requirements, the services of Oerlikon Metco's Coating Solution Centers are available.

Recommended Spray Guns		
Atmospheric Plasma	HVOF	ChamPro
Metco 9MBM	DiamondJet series	SinplexPro 03C
Metco F4MB-XL series	WokaStar series	
TriplexPro-210	WokaJet series	
SinplexPro series		

#### 3.4 Typical Coating Results

Specification		Typical Data	
Recommended Spray Process		See Section 2.5	
Surface Roughness RA	As Sprayed	95 to 10 µm	350 to 400 µin
Macrohardness HRB		90 to 95	
Porosity (vol. %)		< 5	
Bond Strength	Grit Blasted	> 62 MPa	> 9000 psi
	Unblasted	> 55 MPa	> 8000 psi
Maximum Service Temperature		1050 °C	1920 °F

Data provided is typical, but will vary significantly depending on the product chosen, the spray process, spray parameters and spray gun used

## 4 Commercial Information

### 4.1 Ordering Information and Availability

Product	Order No.	Package Size	Availability	Distribution
Amdry 962	1001052	5 lb (approx. 2.25 kg)	Stock	Global
Amdry 9621	1019247	5 lb (approx. 2.25 kg)	Stock	Global
Amdry 9624	1032598	5 lb (approx. 2.25 kg)	Special Order	Global
Amdry 9625	1001053	5 lb (approx. 2.25 kg)	Stock	Global
Amdry 963	1001054	5 lb (approx. 2.25 kg)	Stock	Global
Amdry 964	1001055	5 lb (approx. 2.25 kg)	Stock	Global
Metco 2253A	1312918	5 kg (approx. 11 lb)	Stock	Global
Amdry 365-1	1001073	5 lb (approx. 2.25 kg)	Special Order	Global
Amdry 365-2	1001040	5 lb (approx. 2.25 kg)	Stock	Global
Amdry 365-4	1077116	5 lb (approx. 2.25 kg)	Stock	Global
Amdry 386	1001041	5 lb (approx. 2.25 kg)	Stock	Global
Amdry 386-2	1068951	5 lb (approx. 2.25 kg)	Stock	Global
Amdry 386-2.5	1063702	10 lb (approx. 4.5 kg)	Stock	Global
Amdry 386-3	1058241	10 lb (approx. 4.5 kg)	Stock	Global
Amdry 386-4	1058826	10 lb (approx. 4.5 kg)	Special Order	Global
Amdry 997	1001062	5 lb (approx. 2.25 kg)	Stock	Global
SPM4-2667	1038647	10 lb (approx. 4.5 kg)	Special Order	Global

### 4.2 Handling Recommendations

- Store in the original container in a dry location.
- Tumble contents gently prior to use to prevent segregation.
- Open containers should be stored in a drying oven to prevent moisture pickup.

### 4.3 Safety Recommendations

See the SDS (Safety Data Sheet) for the product of interest localized for the country where the material will be used. SDS are available from the Oerlikon web site at [www.oerlikon.com/metco](http://www.oerlikon.com/metco) (Resources – Safety Data Sheets).

Product	SDS Index No.
Amdry 962	50-424
Amdry 9621	50-424
Amdry 9624	50-424
Amdry 9625	50-424
Amdry 963	50-794
Amdry 964	50-795
Metco 2253A	50-2281
Amdry 365-1	50-781
Amdry 365-2	50-781
Amdry 365-4	50-781
Amdry 386	50-783
Amdry 386-2	50-783
Amdry 386-2.5	50-783
Amdry 386-3	50-783
Amdry 386-4	50-783
Amdry 997	50-797
SPM4-2667	50-783

Information is subject to change without prior notice.