

## Material Product Data Sheet

# Nickel Cobalt Chromium Aluminum [Tantalum, Hafnium Silicon] Yttrium (NiCoCrAl[Ta, HfSi]Y) Thermal Spray Powders

### Thermal Spray Powder Products:

**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 386-5, Amdry 997, SPM4-2667**

### 1 Introduction

Oerlikon Metco's NiCoCrAlY family of gas atomized powders are designed to produce thermal sprayed coatings with excellent high temperature oxidation and hot corrosion resistance.

The presence of cobalt improves coating ductility and hot corrosion resistance. The presence of chromium and yttrium improve oxidation resistance by increasing the activity of aluminum and by improving the spallation resistance of the oxide scale. The function of chromium and aluminum is to provide a reservoir that continually replenishes the oxide scale. Maintenance of the ratio of chromium and aluminum is critical to avoid coating embrittlement. 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 to the coating at high temperatures.

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

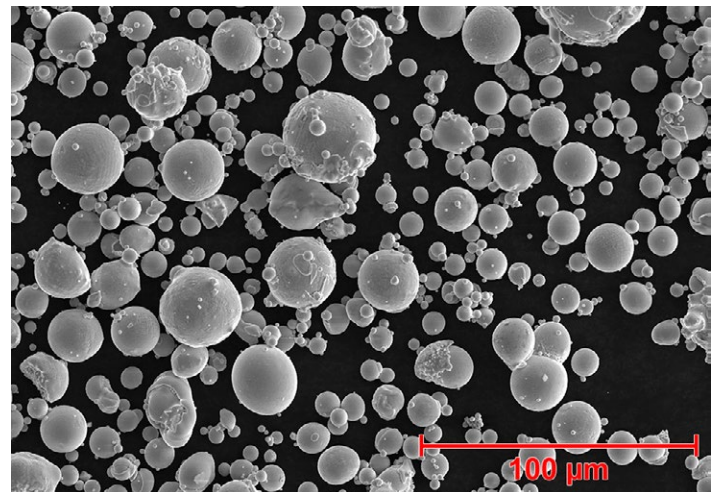
Gas atomization ensures excellent chemical homogeneity and high purity which results in consistent coating results.

#### 1.1 Typical Uses and Applications

- High temperature corrosion resistant bond coats for thermal barrier and oxide-based abradable coatings for gas turbine engine hot section components.
- Oxidation and corrosion resistant coatings for gas turbine blades, vanes and shrouds.
- Repair and restoration of superalloy substrates and parts.

### Quick Facts

Classification	Alloy, nickel-based
Chemistry	NiCoCrAl[Ta, HfSi]Y
Manufacture	Gas atomized
Morphology	Spheroidal
Service Temperature	≤ 1050 °C (1920 °F)
Purpose	High temperature oxidation and corrosion resistance
Process	ChamPro™ controlled atmosphere plasma spray, atmospheric plasma spray or HVOF



SEM Photomicrograph of Amdry 997 showing the morphology typical of these gas atomized products

## 2 Material Information

### 2.1 Chemical Composition

Product	Chemical Composition (wt. %)								
	Ni	Co	Cr	Al	Ta	Y	Hf	Si	Other
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 386-5	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 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 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 386-5	–75	+22	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 product that meets the required customer material specifications and where the cut is suitable for the thermal spray application method to be used. (see Section 2.5)
- Amdry 997 is a premium grade NiCoCrAlTaY gas atomized powder that produces thermal spray coatings having excellent surface 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 (Amdry 365-1 and Amdry 997) produces 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.

## 2.4 Related Products

- CoNiCrAlY powders, such as Amdry 995 series, Diamalloy 4454, Diamalloy 4700 and Metco 4451, produce coatings that can be used as somewhat higher service temperatures and are better suited for hot corrosion environments compared to the Ni-based MCrAlY products.
- Coatings of nickel-based NiCrAlY powders, such as Amdry 962 series, Amdry 963 and Amdry 964, produce coatings with excellent high temperature oxidation protection, but in relatively mild hot corrosion environments compared to the NiCoCrAlY materials.
- Oerlikon Metco is a well-known supplier of MCrAlY materials for thermal spray. Our portfolio includes NiCrAlY, CoCrAlY, NiCoCrAlY and CoNiCrAlY products. We are also a trusted supplier to many OEM and manufacture a portfolio of MCrAlY materials on a proprietary basis.
- Oerlikon Metco also offers a broad range of thermal barrier and abradable oxide ceramic materials, for which these NiCoCrAl[Ta, HfSi]Y products can be used as oxidation resistant bond coats. Please contact your Oerlikon Metco Sales Representative for more information on our thermal barrier and abradable portfolios.

## 2.5 Recommended Spray Process

Product	APS	ChamPro™	HVOF
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 386-5			●
Amdry 997		●	●
SPM4-2667	●		

## 2.6 Customer Specifications

Product	Specification
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 386-5	Pratt & Whitney PWA 1386 (chemistry only)
Amdry 997	Turbomeca LA 657 PF1 Ind. 0
SPM4-2667	Chromalloy C-77

## 3 Coating Information

### 3.1 Key Thermal Spray Coating Information

Specification	Typical Data
Recommended Spray Process	See Section 2.4
Surface Roughness RA	As Sprayed
	9 – 10 µm
	350 – 400 µin
Macrohardness HRB	90 – 95
Porosity (vol. %)	< 5
Bond Strength	Grit Blasted
	Unblasted
	> 62 MPa
	> 55 MPa
	> 9000 psi
	> 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

### 3.2 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

HVOF	Atmospheric Plasma	ChamPro
DiamondJet series	Metco 9MB series	Metco O3CP
WokaJet series	Metco F4 series	
	TriplexPro series	
	SinplexPro series	

## 4 Commercial Information

### 4.1 Ordering Information and Availability

Product	Order No.	Package Size	Availability	Distribution
Amdry 365-1	1001073	5 lb (approx. 2.25 kg)	Special Order	Global
Amdry 365-2	1001040	5 lb (approx. 2.25 kg)	Special Order	Global
Amdry 365-4	1077116	5 lb (approx. 2.25 kg)	Special Order	Global
Amdry 386	1001041	5 lb (approx. 2.25 kg)	Stock	Global
	1034411	10 lb (approx. 4.5 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 386-5	1076298	10 lb (approx. 4.5 kg)	Special Order	Global
Amdry 997	1001062	5 lb (approx. 2.25 kg)	Special Order	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) in the localized version applicable to 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 No.
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 386-5	50-783
Amdry 997	50-797
SPM4-2667	50-783