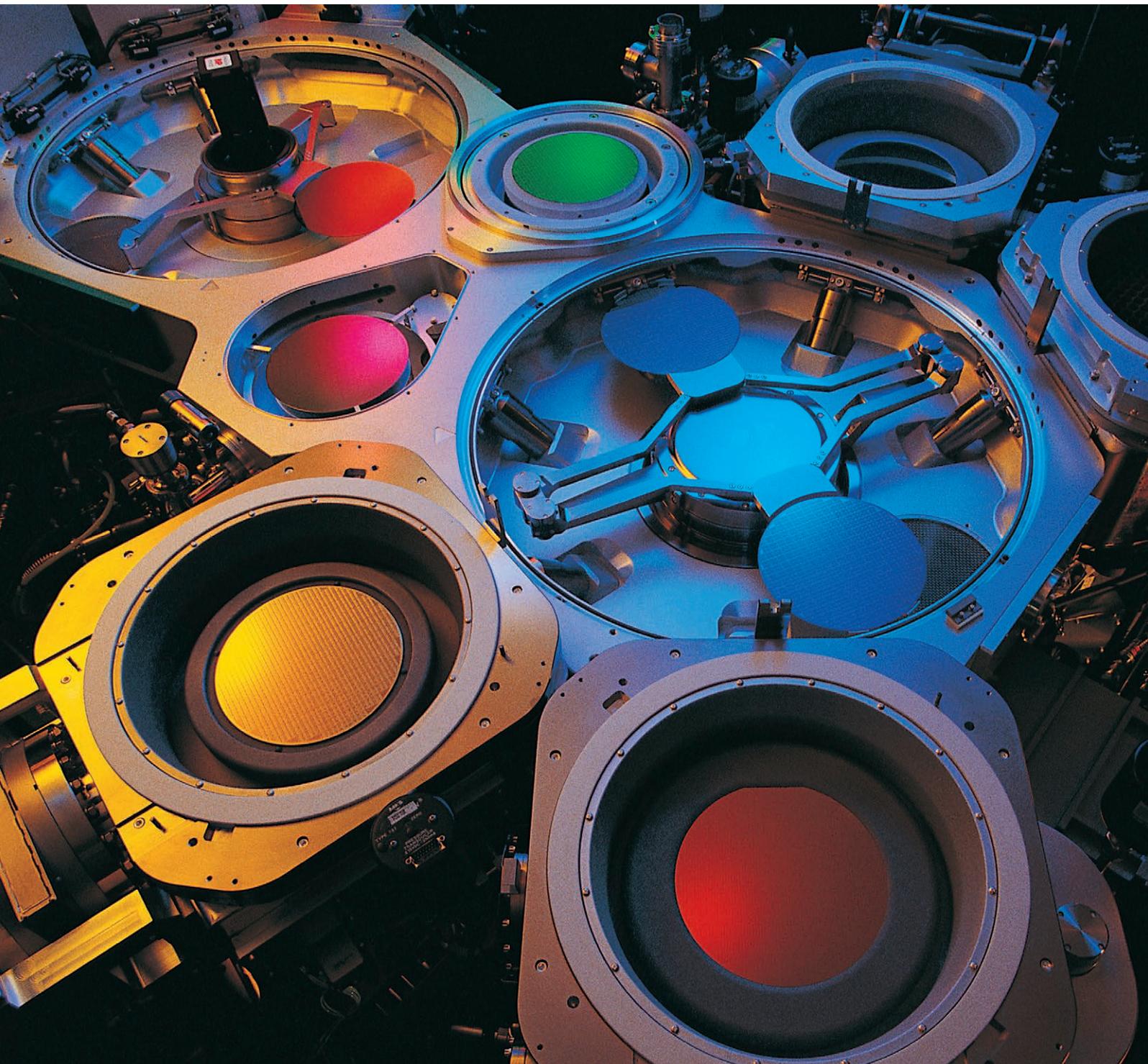


## **Solutions Flash**

Thermal sprayed, ultra high-purity alumina coatings are ideal for semiconductor production tooling

SF-0008.1 – October 2014



### Today's situation

Manufacturers have been rapidly embracing the use of electrostatic chucks (ESCs) for processing semiconductor wafers. Successful application of ESCs not only eliminates moving parts, but also increases the number of semiconductor chips per wafer by reducing edge exclusion, wafer heating and bowing problems.

Aluminum oxide (alumina) is among the most widely used dielectric ceramic material for ESC applications. Its high hardness, excellent dielectric properties, corrosion resistance, good thermal properties and low cost are all advantageous material characteristics for ESC and plasma chamber liner applications in semiconductor tooling.

### The Oerlikon Metco solution

Oerlikon Metco, a world leader in thermal spray technology, offers a cost-effective solution that overcomes the limitations discussed above.

The use of a Oerlikon Metco plasma spray coating solution eliminates size restrictions, and components with very complex geometries can be successfully coated. The number of fabrication steps are reduced compared to those for sintered alumina, and there is no need for sintering aids.

While many industries have successfully used thermal sprayed alumina for a wide variety of applications for over

Traditionally, sintered alumina has been used for these applications; however, sintered alumina has some limitations. First, as the size and complexity of components increases, the difficulty and cost to manufacture these components using sintered alumina increases exponentially. Second, there are a large number of operational steps required to manufacture these components. Also, the necessity of using sintering aids that act as impurities that can have detrimental effects on the properties of the dielectric layer.

More and more, manufacturers seek an alternative that can meet their requirements.

50 years, these conventional alumina materials are unsatisfactory for coatings on semi-conductor tooling.

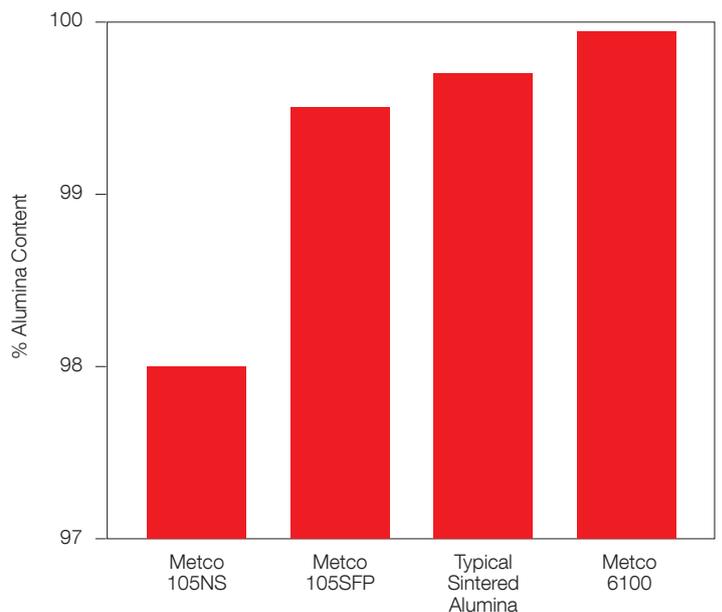
However, our Metco™ 6100 alumina is a superior grade of high-purity alumina that meets the stringent demands of semiconductor processing industry. In addition, Oerlikon Metco's plasma spray systems offer excellent process control technology that apply consistently high quality coatings. Our system integration experts can design plasma spray systems to coat small and large components, even those with complex geometries, effectively and efficiently.

### Solution description and validation

#### Metco 6100 – an ultra high-purity alumina

Our Metco 6100 ceramic is a minimum of 99.95 % pure alumina. The particle size of this material is tightly controlled and ideally sized for coating ESC and plasma chambers. Coatings of Metco 6100 exhibit high densities, with less than 1 % porosity, smooth as-sprayed surface finishes, good corrosion and erosion resistance, and excellent dielectric properties.

Manufactured using a proprietary process, Metco 6100 is a consistently free-flowing material with excellent feed characteristics during the plasma spray process. This results in a high deposit efficiency, which lowers overall coating costs. Yet Metco 6100 is competitively priced compared to other, less pure grades of white alumina.



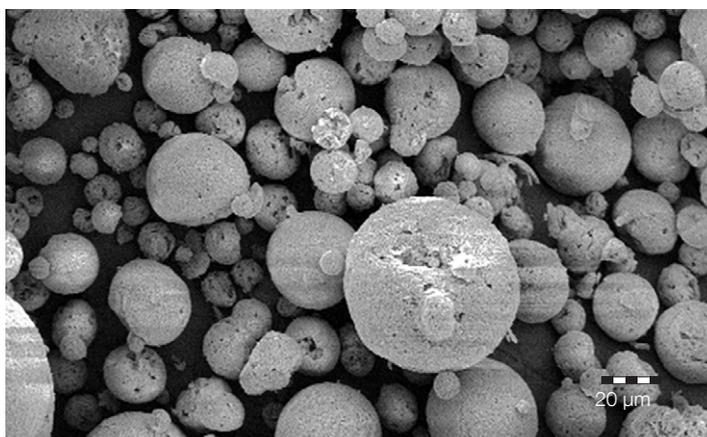
## Metco 6100 powder and processing properties

### Powder characteristics

Chemistry	Al <sub>2</sub> O <sub>3</sub> 99.95+	
Particle size distribution	-62 +11 μm	
Morphology	Spheroidal	
Apparent density	0.5 g/cm <sup>3</sup>	31.2 lb/ft <sup>3</sup>

### Particle flight characteristics

Equipment	Accuraspray-g3	
Particle velocity	150 – 310 m/s	492 – 1017 ft/s
Particle temperature	2140 to 2375 °C	3884 to 4307 °F



Left: The spheroidal morphology of Metco 6100 permits free-flowing, consistent material feed results and high deposit efficiency during spray application. Right: Coatings of Metco 6100 are dense, clean and exhibit electrical properties highly appropriate as a replacement for sintered ceramic components.

## Physical and electrical (dielectric) coating properties

### Physical properties

Surface profile	Ra	2.5 – 6.4 μm	100 – 250 μin
Porosity	Vol %	< 1%	
Microhardness	HV0.3	950 – 1110	
Macrohardness	HR15N	89 – 90	
Deposit efficiency		60 – 65%	

### Electric and dielectric properties <sup>a</sup>

Dielectric strength <sup>b</sup>		24.8 kV/mm	630 V/mil
Permittivity	@ 100 kHz	7.54	
	@ 1MHz	7.44	
Loss tangent factor	@ 100 kHz	0.040	
	@ 1MHz	0.008	
Volume resistivity	@ 25 °C	approx. 10 <sup>10</sup> Ω.cm	

<sup>a</sup> Measurements conducted at Pacific Testing Labs, Inc.

<sup>b</sup> Short Time Test<sup>®</sup> per ASTM D-149 using a rate-of-rise voltage of 500 V/sec

## Application technology

Metco 6100 can be applied using a variety of plasma spray equipment supplied by Oerlikon Metco employing Metco 9MB, Oerlikon Metco F4 or Oerlikon Metco TriplexPro-200 plasma spray guns.

Our advanced UniCoat and MultiCoat system platforms insure the greatest degree of reliability, repeatability and process control through the use of highly state-of-the-art process technology.

Our highly experienced system integration team can design a system that is exactly suited to the customer's specific production requirements and component configuration.

In addition, customers can choose to add online sensor technology to monitor the plasma spray plume during the coating process, for further assurance that the process remains within critical spray parameter coating limits.



A): An integrated system using Oerlikon Metco's MultiCoat advanced spray platform technology provides superior process control and reliability.

B): The Oerlikon Metco TriplexPro-200 plasma spray gun offers unprecedented throughput over extended periods without process drift.

C): The Tecnar Accuraspray-g3 system can be provided with plasma spray systems to monitor plasma jet particle temperature, velocity and position, bringing a new level of quality control and spray process reliability.

## Customer benefits

### Effective

- Excellent dielectric constant, dielectric strength and high resistivity, providing better holding force on the wafers.
- High purity enhances resistance to chemical attack, reducing the chance of wafer or vacuum chamber contamination.
- Excellent alternative to sintered alumina components, especially for larger, more complex component designs.

### Environmental

- Longer service life reduces overall waste levels.
- Reduced potential for wafer contamination during wafer fabrication reduces scrap levels.

### Efficient

- High thermal conductivity of alumina provides better wafer cooling.
- Reduces edge exclusion, wafer heating and bowing effects, increasing overall wafer production.
- Coatings of Metco 6100, particularly when applied using Oerlikon Metco's advanced coating application equipment, have excellent part-to-part repeatability and reliability.

### Economical

- High purity powder at a competitive price.
- High deposition efficiency lowers spray process waste and labor costs.
- Resistant to plasma etching and cleaning, increasing ESC service life with less downtime.