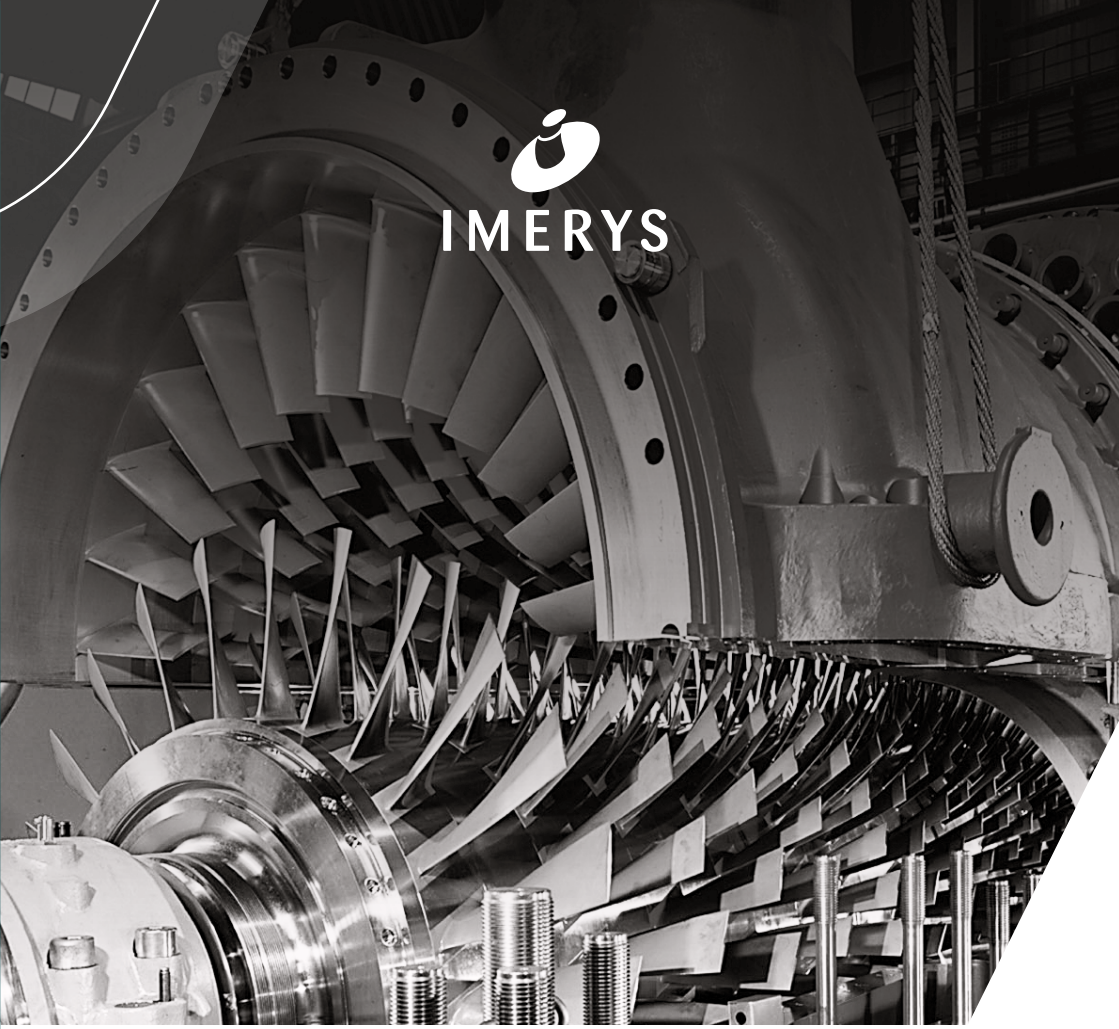


IMERYS

MATERIAL SOLUTIONS FOR

THERMAL SPRAY COATINGS

ADVANCED CERAMICS
ENGINEERING THE FUTURE
WITH SUSTAINABLE SOLUTIONS.

INTRODUCTION AND APPLICATIONS

When looking at "Thermal Spray Coatings" and Zirconia most people think about gas turbines for power generation or aviation. This is also the case for us. Nevertheless, our raw materials are used for various thermal spray processes and applications which include:

- **Atmospheric Plasma Spray** with the main use in gas turbines or aviation engines, but also sputtering targets, conveying rollers, kiln furniture, fuel cell production or diverse industrial machinery parts,
- **Suspension Plasma Spray and Fine Particle Plasma Spray** in e.g. aviation engines and
- **Aerosol Deposition** as a growing application where fused & crushed powders show benefits.

When thinking about electrical insulating, wear and chemical resistant coatings, we also provide alumina powders for APS, HVOF or SPS processes that are used in the automotive, aerospace and also chemical industries.

Fused & crushed type Aluminas are also available at Imerys for blasting applications for surface preparation.

Part of our daily work within thermal spray coatings is to think and deal e.g. with customised chemistries, purity levels or particle size distributions to deliver the right product for each and every application.

SPECIFIC APPLICATION EXAMPLES

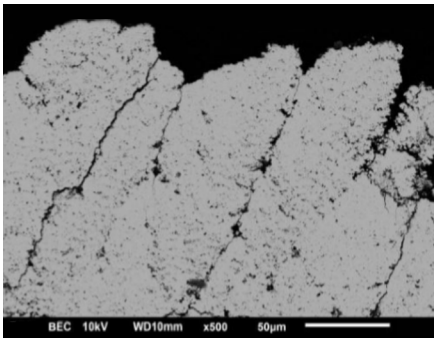
Atmospheric Plasma Spray (APS), Suspension Plasma Spray (SPS), Fine Particle Plasma Spray (FPPS) and Aerosol Deposition (AD) are using many kinds of Zirconias combined with a wide range of particle sizes.

In case of **thermal barrier coatings (TBC)** the zirconia coating enhances thermal insulation up to 1200°C in order to protect the superalloys. Advanced thermal barrier coatings based on Zirconia allow even higher temperatures thanks to even lower thermal conductivities.

Thermal Spray gun

Our fused and crushed powders feature an extremely narrow particle size distribution or high purity. They allow different coating morphologies like dense (<1% porosity) or porous (~20% porosity) structures as well as dense-vertical-crack type (DVC) for better erosion and/or thermal shock resistance.

We also manufacture fine powders for suspension plasma spraying that can result in feathery like or columnar microstructures.



Thermal Barrier Coating
made by Suspension Plasma Spray

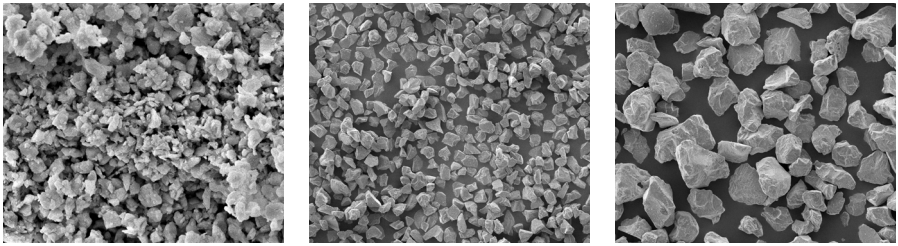
OUR OFFER

Our main raw materials for thermal spray coatings are **supplied from our plant in Germany.** Most common are **ZIONIC Zirconia and ALODUR Alumina.** Based on our integration and the vast fusion & sizing technologies, it is possible for us to follow most customer wishes.

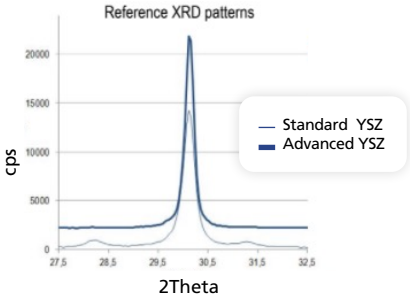
This is visible by the zirconia products that we can offer: 7% to 48% Yttrium stabilised Zirconia (for «regular» and advanced TBCs or CMAS resistant coatings) but also pure monoclinic Zirconia, Magnesium Zirconate or Calcium stabilised Zirconia. The standard particle size offering is from d50 ~0.3µm up to ~40µm (in many steps).

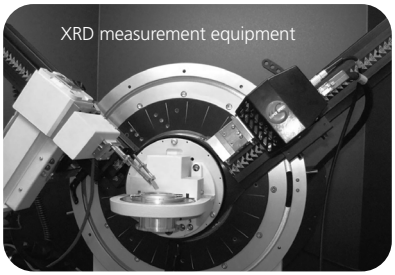
For **atmospheric plasma spray applications of YSZs,** we bring, together with our customers, new products into the gas turbine market. Those result in longer coating lifetime or allow higher maximum temperatures. The selection of the suitable fusion technology or scale as well as our expertise with classification technologies plays a very important aspect that allows the highest performance.
Thanks to the various fusion technologies available at Imerys and our expertise in raw materials, **our fused and crushed powders can reach very high purities (99.9+%)**

and are fully stabilized even with low yttria content compared to conventional processes. Our proprietary processes allow us tight controls of the particle size distribution (low d90 to d10 ratio) as well as low amount of fines with blocky fused and crushed grains to enhance the flowability and the use of our powders for thermal spray applications.

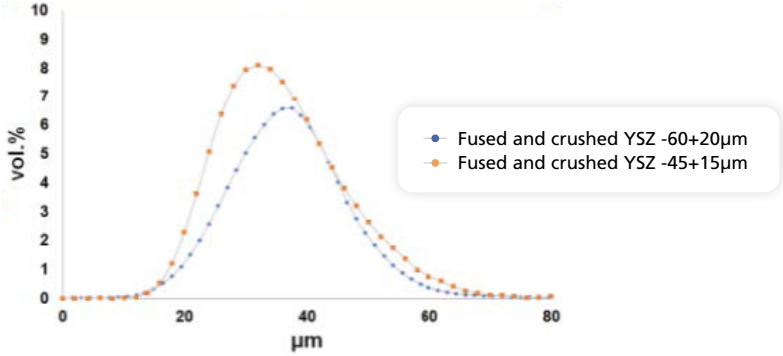


SEM pictures of various, fused YSZ powders showing the range of PSD (left: -2µm, center: -20+9µm, right: -60+20µm)





XRD of 2 different ~8wt% YSZs with the advanced YSZ at full stabilisation

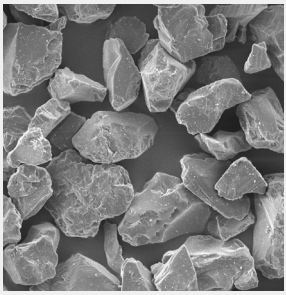


Example of Particle Size Distribution of -60+20µm and -45+15µm size cuts

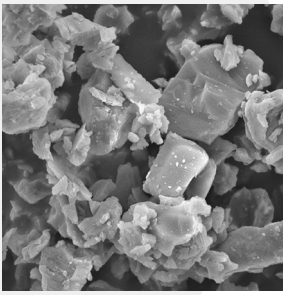
Example of one type of arc furnace

Our Alumina for thermal spray coatings also has diverse facets. Not just regular spray powder sizes such as -45+5µm or the very narrow sized -22+5µm are used, also fine sizes with a d50 of ~1.50 to 5.5µm have their authority in barrier coatings. Soda content is important when it comes to high electrical insulation but it is not always said to be the most critical aspect.

For thermal spray and alumina coatings, Imerys offers white fused alumina (including low soda type) and brown fused alumina that fit customer needs either for electrical insulation, wear resistant or chemical resistant coatings



Example of Particle Size Distribution of -60+20µm and -45+15µm size cuts



SEM picture of a Fused Alumina ZWSK F2000 (d50 ~1.5µm)

Fused Alumina ingots and lumps that are processed into micrometric sized powders

OUR TYPICAL PRODUCTS

		YSZ	Mg Zirconate
Applications	Atmospheric Plasma Spray	✓	✓
	Suspension Plasma Spray and Fine Particle Plasma Spray	✓	
	Aerosol Deposition	✓	
Products	Product category	7% Y Zirconia SP 7.5% Y Zirconia UHP 13% Y Zirconia HP 16% Y Zirconia HP 20% Y Zirconia HP 48% Y Zirconia HP	MgZr
	Size category	-1µm -2µm -5µm 2-3.5µm 3-5µm -10µm d50 2µm -45+15µm -60+20µm -70+20µm	to be discussed
Basic product information	Fused & crushed type	✓	✓
	Spherical type		
	Other type (calcined, chemical,...)		
	Primary crystal size (for Al_2O_3s) or grain size (for others)		
	Typical soda content		
	<10µm	✓	
	-45+15µm, -60+20µm, -70+20µm	✓	✓
	-20+5µm, -22+5µm, -45+5µm, -45+22µm, -90+45µm		
	Other	✓	

Others:
- Silicates, zirconates, mullite or cordierite
- Fused Alumina: blasting media (ZESK, RBT 9, OSO)

ZIONIC™				ALODUR®
CaSZ	ZrO_2	Chemical ZrO_2	Calcined Al_2O_3	Fused Al_2O_3 *
✓	✓	✓		✓
			✓	
	✓		✓	
ZCO-GW-0	ZCO-N	ZRO elec	EVT	ZWTS
-45+15µm -60+20µm	-45+15µm -60+20µm	1.5µm 3-5µm -325#	304 404	-22+5µm -45+5µm -45+22µm -90+45µm other
✓	✓			✓
		✓	✓	
			~2.8µm (for 304) ~4.0µm (for 404)	
			~0.06%	0.1-0.2% 0.15-0.3% ~0.4%
		✓	✓	
✓	✓			
				✓
				✓

IMERYS

THE WORLD'S LEADING PROVIDER OF MINERAL-BASED SPECIALTIES FOR INDUSTRY

Imerys offers high value-added solutions to many different industries, ranging from process manufacturing to consumer goods.

- We provide innovative and quality products to fit with our customers' needs
- We consider Safety as a priority
- We respect the world in which we operate

Over 15,000 customers

Sales in 142 countries

16,300 employees

At Imerys, we fulfill our role in society in a responsible way.
The technical expertise and innovative mindset of our people enable us to extract and transform minerals responsibly and in a sustainable way over the long term.

For further information, please contact :

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