



CERAMIC FUEL CELLS LIMITED

*Clean power for your home*

# Introduction to Zirconia Powder Market

Presented to

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Candy Park**



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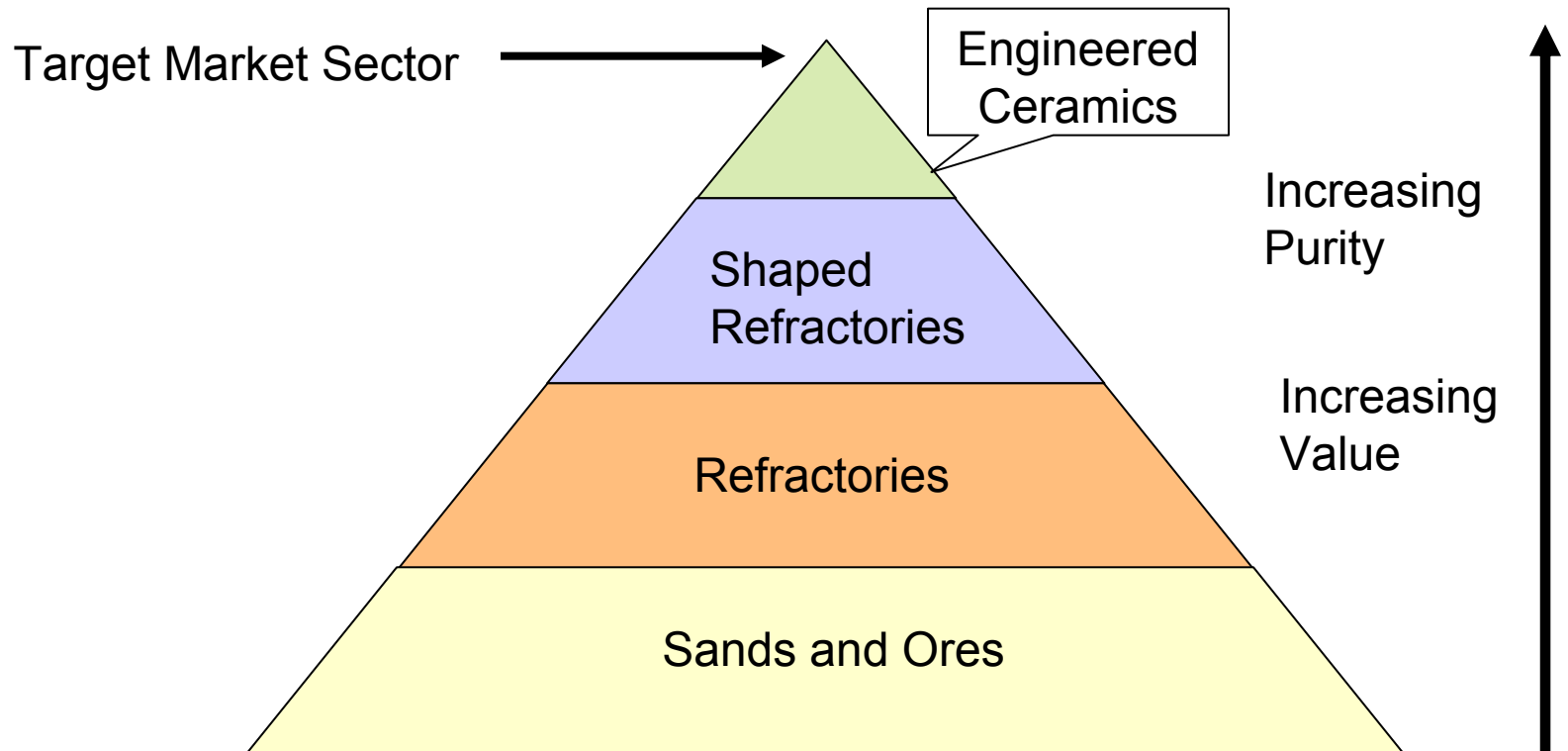
## **Introduction**

- **Overview of zirconia powders**
- **Properties of powder produced at CFCL**
- **Market applications**
- **Summary**



# Overview of zirconia powders

## Value Pyramid



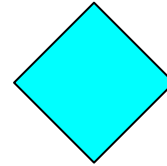


## Zirconia Powder Characteristics

### Crystal Types



Cubic  
stable at high temp



Tetragonal  
Partially stable



Monoclinic  
stable at low temps

**Crystallite size** – sizes of individual crystals within the powder particle

**Alloy type** – additions of 3-10% yttria stabilise the tetragonal crystal

**Powder** – agglomerations of crystals to form a particle

**Toughening** – change from tetragonal to monoclinic results in expansion

**Hydrothermal stability** – 3%yttria alloys can change from tetragonal to monoclinic with steam. Resistance to this is *hydrothermal stability*

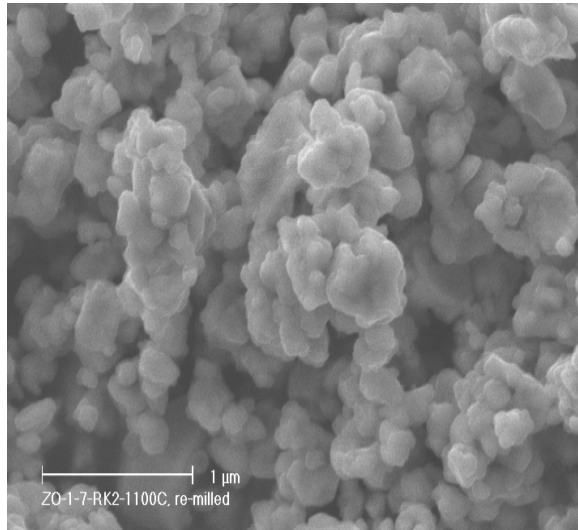


## Zirconia Properties

<b>Characteristics</b>	<b>3YSZ 3% yttria</b>	<b>5YSZ 5% yttria</b>	<b>8YSZ 8%yttria</b>
Stability	partially	partially	partially
Conductivity	lowest	good	very good
Toughness	best	intermediate	lowest
Hydro Stable	poor	reasonable	good
Hardness	good	good	good
Strength	high	high	high



## CFCL Powder Plant



<b>Purity</b>	> 99.9 %
<b>Alloy ranges</b>	3-10% Yittria:zirconia
<b>Crystallite size</b>	~50nm ( $10^{-9}$ m)
<b>Powder size</b>	< 1000nm mean size (<1 $\mu$ m)
<b>Plant Capacity</b>	20 T p.a. (50T multiple shifts)

# Potential Market Applications

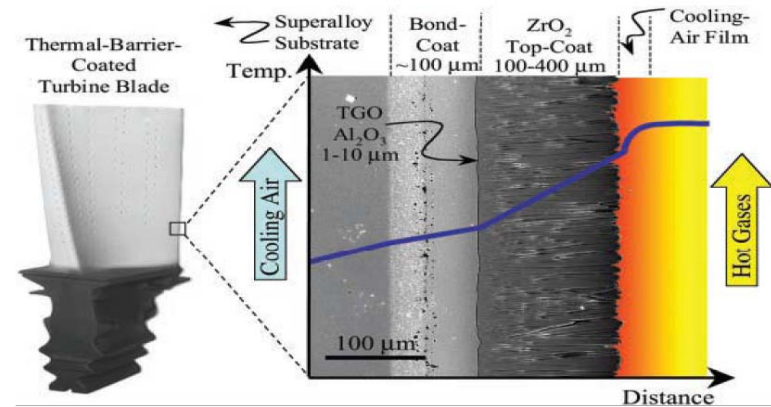
## Barrier Coatings

### Biomedical



**Growth Market >8% cga**

**Material value £70 -100 per kg**



**Growth Market >5% cga**

**Material value £70 – 180 per kg**

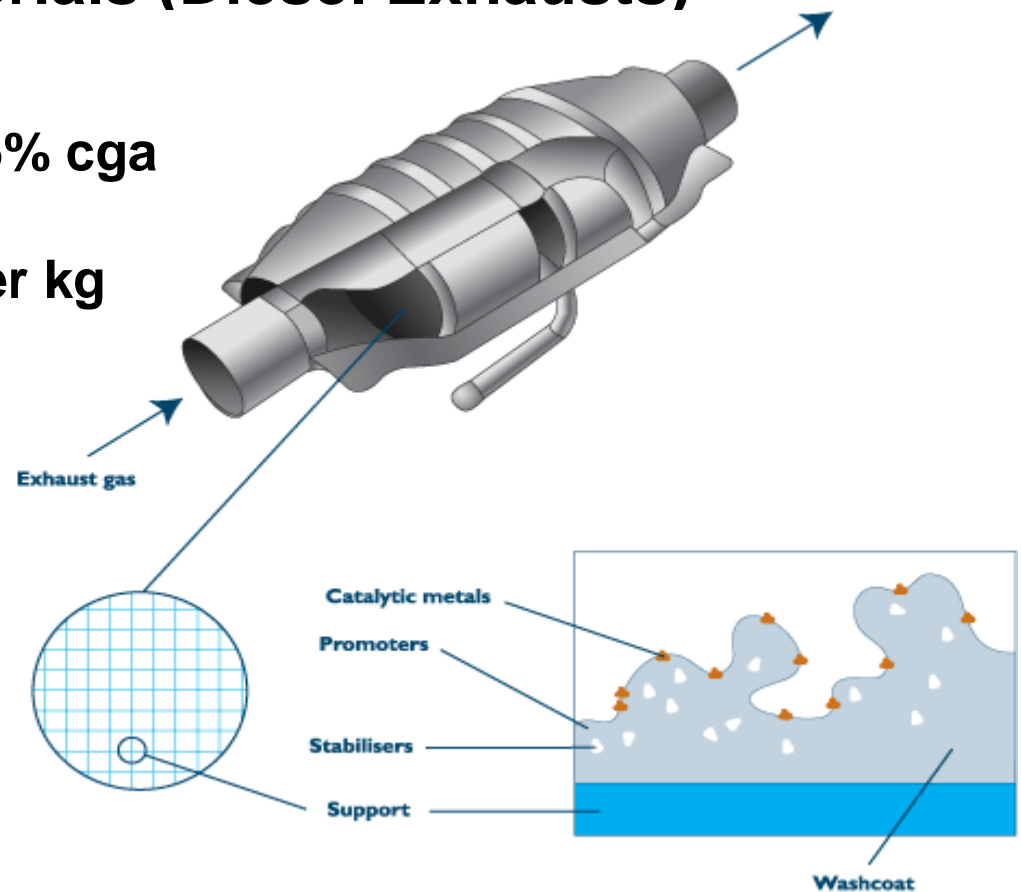


# Potential Market Applications

## Catalyst Support Materials (Diesel Exhausts)

Global Market growing 5% cga

Materials value £500+ per kg





## Summary

### High value material:

- **High purity**
- **Small crystallite size**
- **Closely controlled powder size**
- **High temperature stability**
- **Unique process provides more control over material characteristics**
- **Process protected by patents and know-how**