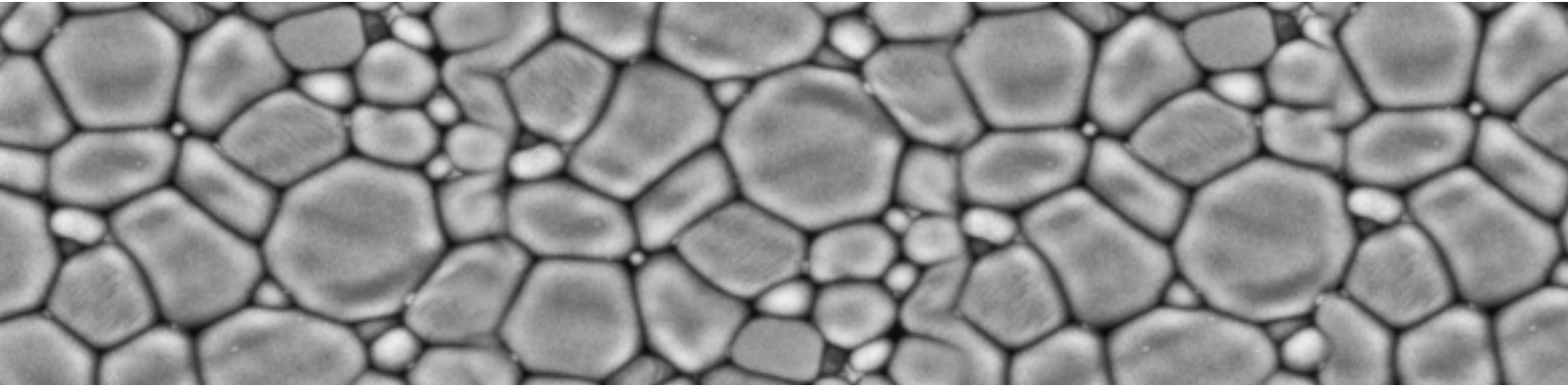


CERIA STABILIZED ZIRCONIA:  
WHY CSZ HAS A SUPERIOR RESISTANCE TO  
LOW-TEMPERATURE DEGRADATION THAN YTZP OR MSZ

---



## OVERVIEW

---

Stabilized zirconia ceramics such as Ytria-stabilized Tetragonal Zirconia Polycrystal (YTZP) are so strong and durable they have been called the ‘ceramic analogue of steel’. That said, YTZP can be vulnerable to low-temperature degradation, particularly in moist environments.

This White Paper explains how, for YTZP and MSZ, the transformation toughening phenomenon can be undone under certain environmental conditions. It has been known that Ceria Stabilized Zirconia (CSZ) has better resistance to low-temperature degradation compared to YTZP and MSZ. A hypothesis for the mechanism by which this occurs will be discussed.

## TRANSFORMATION TOUGHENED ZIRCONIAS

---

In an earlier White Paper, we explained how doping with oxides such as Yttria, Magnesia and Ceria can markedly improve the strength and toughness of Zirconia ceramics by stabilizing a particular crystal structure called the tetragonal phase ( $t\text{-ZrO}_2$ ). In these stabilized Zirconias, such as YTZP or CSZ, the stress field around a crack is enough to prompt a highly localized phase transformation and volume expansion which squeezes the crack shut. Given that it is the presence of the tetragonal phase  $t\text{-ZrO}_2$  which allows this, it is easy to see how the strength and toughness of stabilized Zirconias is completely dependent upon the stability of the tetragonal phase. The correct choice of dopant oxide can be crucial if the ceramic is to remain stable in moist environments.

## LOW TEMPERATURE DEGRADATION

---

Both research and practice have shown that the stability of the tetragonal phase  $t\text{-ZrO}_2$  in Yttria-stabilized Tetragonal Zirconia Polycrystal is limited in the presence of water. At even low to moderate temperatures, the tetragonal phase ( $t\text{-ZrO}_2$ ) transforms to the monoclinic ( $m\text{-ZrO}_2$ ), not only in a tiny region ahead of a crack, but all across the exposed surface. Because the monoclinic crystal structure is bigger by volume, this extensive phase transformation causes cracking and severe wear or failure.

## SUPERIOR DEGRADATION PROPERTIES OF CERIA STABILIZED ZIRCONIA

---

Some current research suggests that the lack of oxygen vacancies and or hydrogen defects in the crystal structure is key. Water molecules are thought to invade the surface and destabilize the tetragonal phase by sitting in these vacancies. The research hypothesizes that the absence of the vacancies is a result of the tetravalent Cerium substitute directly for the  $\text{Zr}^{+4}$  ions.

The use of Ceria as a stabilizing agent may therefore explain the improved low temperature degradation properties. With a potentially reduced vulnerability of molecular water attack, CSZ offers a more robust Stabilized Zirconia material when low temperature degradation properties are in question.

It has been decades since scientists and materials engineers discovered the occurrence of low temperature degradation in stabilized zirconias. The research and explanations for the exact mechanisms is still ongoing.

Ceria Stabilized Zirconia (CSZ) is able to withstand low temperature degradation better than YTZP and MSZ. This is why CSZ is often chosen over YTZP or MSZ when low-temperature degradation is a factor.

Consider CSZ a top candidate when choosing a ceramic material for high-strength and toughness in moist, challenging environments.

## SPECIFICATIONS AND APPLICATIONS

---

CSZ ceramics can be used in a wide range of applications including instrumentation, sensors, seals, bearings, dies for nonferrous metals, thermal coatings for aero engines and diesel engine parts to mention only a few.

## MSZ RELATED SERVICES\*\*

---

- Powder Preparation
- Forming
- Green Machining
- Firing
- Grinding and Cleaning
- Coating / Glazing
- Metalizing and Plating
- Metrology

## CONTACT US

---

For more information call or email us. You can also learn more about our extensive capabilities at [www.ceramics.net](http://www.ceramics.net)

### **Superior Technical Ceramics**

600 Industrial Park Rd.  
St. Albans, VT 05478  
Tel (802) 527-7726  
Fax (802) 527-1181  
[sales@ceramics.net](mailto:sales@ceramics.net)

---

Superior Technical Ceramics products and services are subject to the Company's standard terms and conditions, available on request or at [ceramics.net](http://ceramics.net). For more information contact an authorized Superior Technical Ceramics representative. Unless noted otherwise, trademarks and service marks herein are the property of Superior Technical Ceramics and may be registered in the United States and/or other countries. Superior Technical Ceramics products named herein may be protected by one or more U.S. and/or foreign patents. For more information, contact [sales@ceramics.net](mailto:sales@ceramics.net). Specifications are subject to change without notice. Superior Technical Ceramics sells its products and services in accordance with the terms and conditions set forth in the applicable contract between Superior Technical Ceramics and the client.