CERACONDUCT – FUNCTIONAL COATING FOR STABLE HIGH VOLTAGE IN VACUUM

CeraConduct is a ceramic functional coating for the targeted dissipation of surface charges on ceramics under high voltage in vacuum. Through the controlled reduction of electron avalanches (SEE effect: secondary electron emission coefficient 1:10 for Al_2O_3), charge clusters, and arcing, **Cera**Conduct significantly increases electrical stability and operational reliability. The insulating properties of the ceramic are fully retained. The result is durable components and reliable operation even under extreme conditions.

TECHNICAL SPECIFICATIONS (EXCERPT)

- Coating type: ceramic functional layer
- Layer thickness: < 1 µm
- Electrical resistance: high (> 1×10^9 Ω)
- Electrical conductivity: low, defined
- Temperature resistance: ≥ 800 °C
- Vacuum suitability: UHV-compatible, non-outgassing
- (< 10^{-10} mbar)
- Chemical resistance: very good against organic solvents
- Adhesion: permanent, non-washable
- Substrates: ceramic materials, e.g., Al_2O_3

TYPICAL APLLICATIONS

- High-voltage vacuum insulators
- X-ray and imaging systems
- Electron beam sources
- Particle accelerators
- Direct current or low-frequency applications

ALUMINA SYSTEMS – CERAMIC SOLUTIONS FOR THE HIGHEST DEMANDS

Alumina Systems develops and manufactures high-quality ceramic components and functional solutions for demanding industrial and scientific applications. Its core competence lies in vacuum tight ceramic-to-metal joined components. Through innovative 3D printing techniques, the company can also produce ceramic components with highly complex geometries that are impossible to manufacture using other shaping methods. The company combines in-depth materials engineering expertise with practical development competence. The benefit from customized solutions, a high level of vertical integration, and reliable quality – from prototypes to series production.

LET US TALK ABOUT YOUR APPLICATION

We would be pleased to show you how **Cera**Conduct sustainably improves the operational reliability of your ceramic high-voltage insulators.

OUR EXPERTS – ALWAYS FOR YOU AVAILABLE!

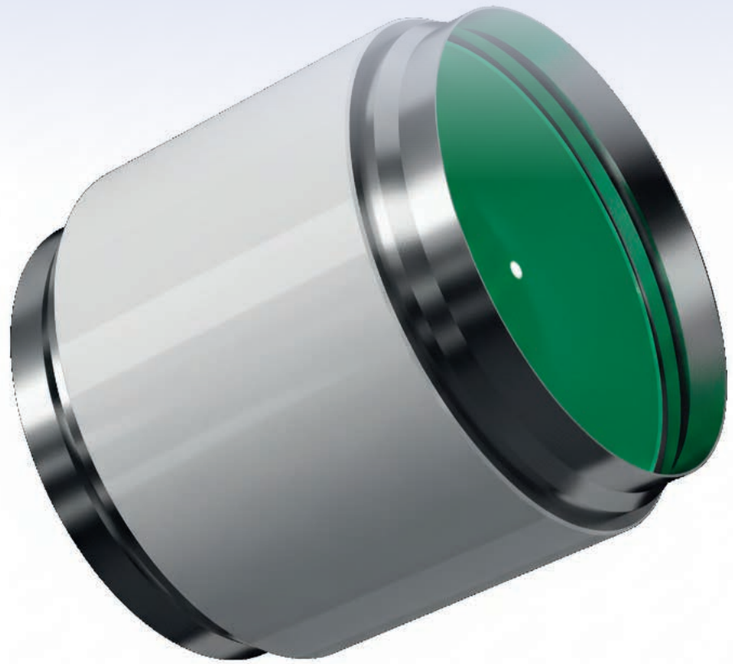
Dr. Steffen Walter
Head of Product Development
swalter@alumina.systems

Dipl.-Ing. Norbert Müller
Head of Sales & Marketing
nmueller@alumina.systems

ALUMINA SYSTEMS
A Brilliant Idea behind Every Product

ALUMINA SYSTEMS GmbH
Bahnhofstr- 43 | 96257 Redwitz / Germany
Tel.: +49 9574 654320 | E-Mail: info@alumina.systems
www.alumina.systems

ALUMINA CERACONDUCT



CERACONDUCT: **STABLE HIGH VOLTAGE IN VACUUM – WITHOUT COMPROMISE**

High voltage in vacuum poses particular challenges for ceramic feedthroughs and insulators. Unwanted surface charges can lead to arcing, breakdowns, and premature component failure. **Cera**Conduct from Alumina Systems addresses this very issue. The innovative ceramic functional coating dissipates surface charges in a controlled manner and prevents arcing in vacuum. This results in higher safety, longer product lifespan, and reliable operation of your systems.

RELIABLE HIGH-VOLTAGE INSULATION IN VACUUM APPLICATIONS

HIGH VOLTAGE IN A VACUUM: WHEN PROVEN MATERIALS REACH THEIR LIMITS

Ceramic materials such as alumina oxide (Al_2O_3) have been a key component of high-voltage insulators for decades. Their high dielectric strength, thermal stability, and suitability for vacuum applications make them the first choice for demanding applications. However, practical experience shows that even high-quality ceramic components can fail prematurely, especially under high voltage in vacuum.

Applications with direct current or low frequencies are particularly critical when long insulation distances are involved. Electrons being knocked out by adjacent metal parts create electrical charges on ceramic surfaces that cannot dissipate in a controlled manner. This results in unstable electrical states that compromise the safety and lifespan of the entire system.

THE PHYSICAL BACKGROUND: SECONDARY ELECTRON EMISSION

In vacuum, high electric fields act directly on the surfaces of the materials used. Electrons are ejected from metal or ceramic surfaces and accelerated by the electric field. When these electrons hit the ceramic surface, they knock out further electrons.

This effect is described by the secondary electron emission coefficient (SEEC). For ceramic materials, this value is typically greater than one – meaning that each electron impact generates more than one additional electron. The process is self-reinforcing and leads to an electron avalanche along the ceramic surface.

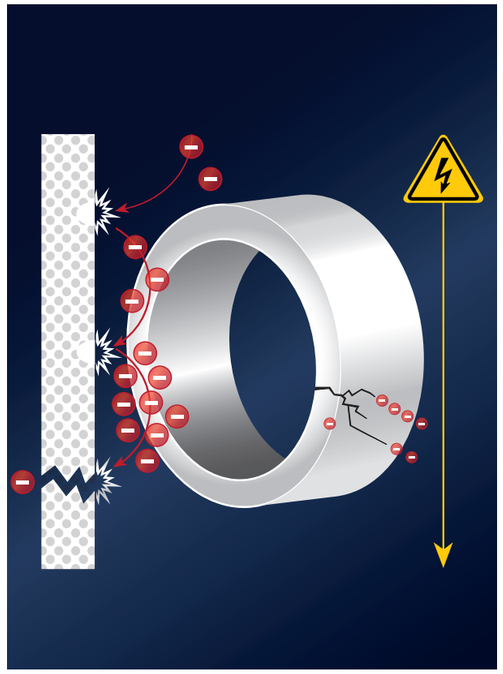
THE CONSEQUENCES

The effects of these electron avalanches are serious. Local charge accumulations, known as charge nests, form on the ceramic surface. Simultaneously, arcing can occur between the ceramic and adjacent metallic components.

THESE EFFECTS OFTEN LEAD TO:

- damage of the ceramic surface
- electrical breakthrough significantly below the actual material strength
- Unstable operation and unplanned plant shutdowns
- in the worst case leading to complete failure of the component and loss of vacuum.

Unstable operation and unplanned plant shutdowns in the worst case leading to complete failure of the component and loss of vacuum.



APPLYING A HIGH VOLTAGE TO A CERAMIC MATERIAL IN VACUUM CAUSES AN ELECTRON AVALANCHE. IN THE WORST CASE, THIS CAN DAMAGE THE CERAMIC. ELECTRICAL BREAKTHROUGH OF THE CERAMIC CAN OCCUR. THE VACUUM IS LOST AND THE SYSTEM BECOMES UNUSABLE.

THE SOLUTION: CONTROL INSTEAD OF ESCALATION

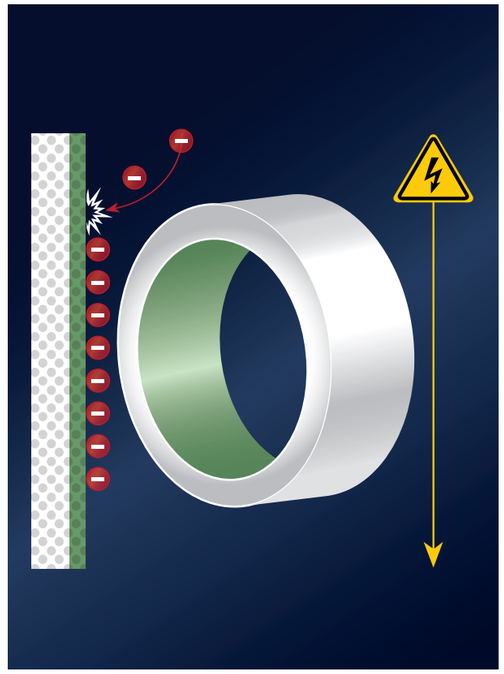
The key to avoiding these effects lies not in increasing material thickness or insulation, but in the targeted control of surface charges. This is precisely where **Cera**Conduct from Alumina Systems comes in.

CeraConduct is a specially developed ceramic functional coating with a layer thickness of less than 1 µm. It has high resistivity but a defined low electrical conductivity. This allows free electrons on the ceramic surface to be continuously and controllably dissipated before they can accumulate and trigger critical effects.

CERACONDUCT IN APPLICATION

The coating fundamentally alters the electrical behavior of the ceramic surface. Electrons are no longer stored locally, but flow away in a controlled manner. Electron avalanches, charge nests, and arcing are effectively suppressed, while the insulating properties of the ceramic base material are fully retained.

The result is a significantly increased electrical stability of the component – even at high voltages in vacuum and under demanding operating conditions.



A COATING ON THE INNER CERAMIC SURFACE „CERACONDUCT“ (GREEN)– A DEVELOPMENT OF ALUMINA SYSTEMS – CONDUCTS THE ELECTRONS. NO ELECTRON AVALANCHE OCCURS. THE CERAMIC IS PERMANENTLY VACUUM-TIGHT.

TECHNICAL FEATURES THAT IMPRESS

CeraConduct was specifically developed for use in highly sensitive vacuum applications:

- High resistance (> 1×10^9 Ω)
- Low, defined electrical conductivity
- Layer thickness < 1 µm
- Temperature resistant up to at least 800 °C
- UHV-compatible and non-outgassing (< 10^{-10} mbar)
- Very good chemical resistance to organic solvents
- Permanently adhesive, not washable

These properties make CeraConduct a reliable solution for long-term stable high-voltage applications.

TYPICAL AREAS OF APPLICATION

CeraConduct is used wherever ceramic insulators need to function reliably under high voltage in vacuum, including in:

- X-ray systems
- vacuum technology
- electron beam sources
- particle accelerators

YOUR ADDED VALUE WITH ALUMINA SYSTEM

With **Cera**Conduct, Alumina Systems offers not just a coating, but a practical solution for one of the key challenges of ceramic high-voltage insulators. The result is increased operational reliability, longer service life, and reduced overall costs – from development to operation.