



News Release

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ZIA identifies principal areas of research relating to zircon, zirconium and zirconia

The Zircon Industry Association (ZIA) annually identifies the most popular areas of research relating to zircon and its downstream derivatives.

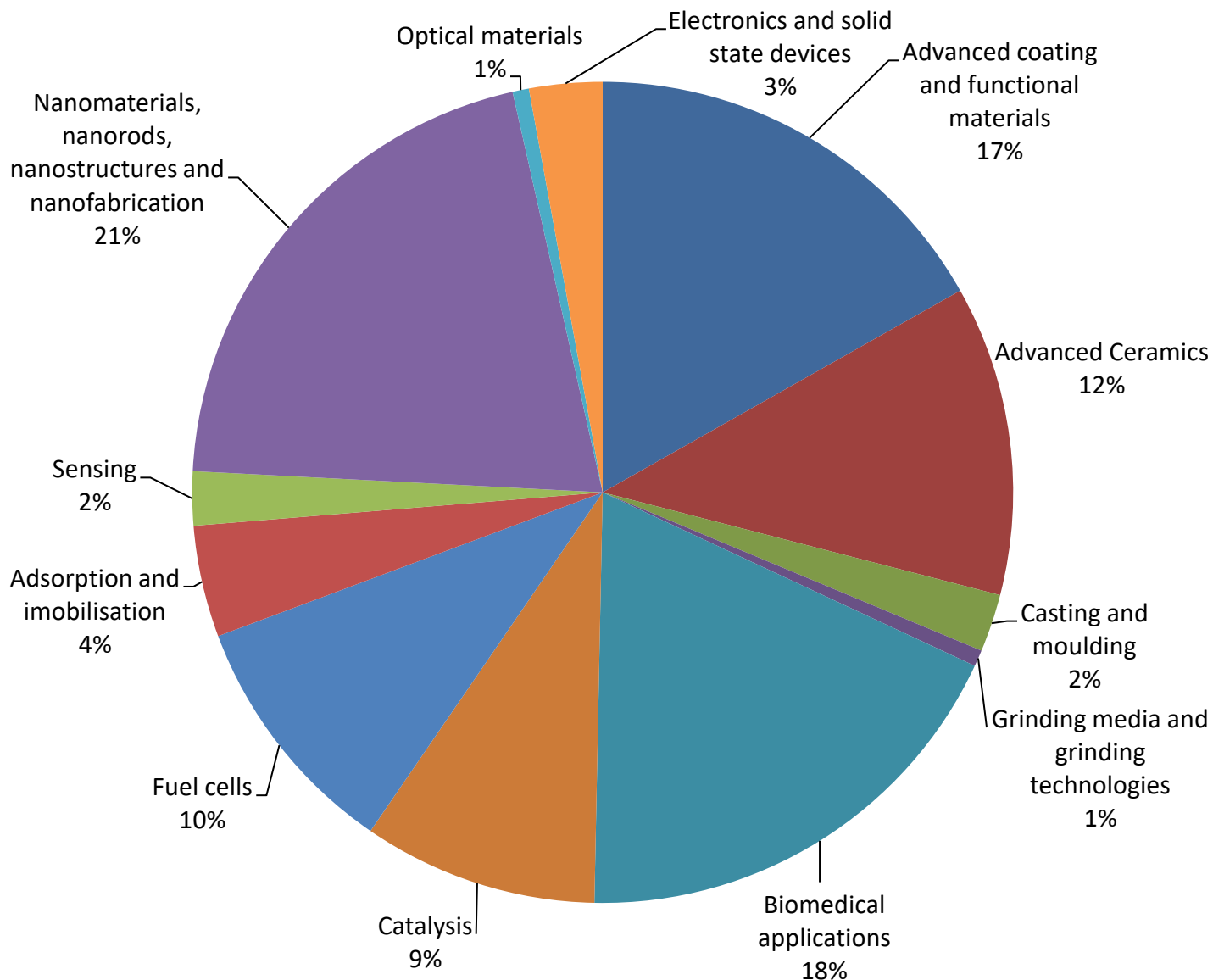
Following a review of over 2,600 peer-reviewed papers published in 2019, it has been possible to identify these areas of research and make an informed assumption as to the likely potential for industrial application.

Specialists at Centro Ceramico, Bologna (Italy) carried out the literature search and categorised the papers into subject areas. Those areas with more than 30 publications were considered to have a high potential market demand, indicating that the interest of the scientific community is high and, therefore, the application might merit exploitation at an industrial level.

The most popular fields of zircon-related research were as follows:

- Nanomaterials, nanorods, nanostructures and nanofabrication
- Advanced coating and functional materials
- Biomedical applications
- Advanced ceramics
- Fuel cells
- Catalysis

When compared to a similar review of publications in 2018, Advanced coatings, Nanoparticles, Fuel cells and Catalysis all saw their percentage share of research increase in 2019. While the areas of Biomedical applications and Advanced ceramics saw a decrease in 2019.



Further details on the results

The most popular field of research in 2019 was **nanomaterials, nanorods, nanostructures and nanofabrication**. 37% of the 545 papers were focused on industrial applications. These included:

- ZrO_2 and ZrO_2 composite thin films with magnetic, ferroelectric and dielectric properties
- ZrO_2 and ZrO_2 composite thin films and thin coatings for anti-wear and anti-corrosion applications
- Zirconium oxide doped carbon nanotubes and zirconium nanotubes

The second most popular field of research in 2019 was **biomedical** applications. Of the 485 papers in this field, 49% focused on industrial applications. These included:



- ZrO₂ and ZrO₂ composites with treated or functionalised surface (e.g. with hydroxyapatite or bioglass) for better osteointegration or adhesion and/or bioactivity
- ZrO₂ and ZrO₂ composites for dental crowns, bridges, implants, veneers
- Positron emission tomography (PET) imaging with radiolabelled Zr89

These have potential applications within the fields of dental and orthopaedic implants, bioimaging and tumour diagnosis.

The third most popular area of research was within the field of **advanced coating and functional materials**. 78% of the 444 papers in this area were focused on industrial applications, including:

- Zr compounds and ZrO₂ composites as protective coatings for ceramics against heat, wear, abrasion and corrosion. Also as protective thermal barrier coatings for metals, alloys and glasses.
- Zr and ZrO₂ composite coatings produced by new techniques such as plasma spray, pulse electrodeposition, aerosol gas deposition
- Zr compounds and ZrO₂ composite coatings to enhance bioactivity, antimicrobial properties and corrosion resistance of implants

These have potential applications in the fields of aerospace, automotive, power plants, petroleum industries, chemical processing and possible biomedical applications.

The next most popular area of research was **advanced ceramics**. Of the 322 papers in this area, 39% focused on industrial applications including:

- Zirconia ceramics and composites (PZT and doped PZT) with piezoelectric and dielectrics properties
- Ultra-high temperature and corrosion zirconia-based ceramics
- Zirconia and zirconia based composites for dental implants and dental parts (crowns, bridges, veneers, screws and abutments)
- Zr alloys and Zr as alloying elements in metals

These have potential applications in the fields of electronics, automotive, power plants, petroleum industries, chemical processing, biomedical and dental applications.

The area of zirconia use in **fuel cells** saw increased research interest this year with 42% of the 257 papers focused on industrial applications including ZrO₂ and ZrO₂ composites, anodes for solid oxide fuel cells and Zr compounds, ZrO₂ and ZrO₂ composites as electrolyte for solid oxide fuel cells. Importantly, these have potential applications in clean, efficient electricity generation, renewable fuel production and electricity storage. **Catalysis** was also an area that saw increased research interest in 2019 with 244 paper published, 72% of which focused on industrial applications. These included research on Zr compounds, ZrO₂ and ZrO₂ composites as catalysts and catalyst support for gas catalysis e.g. CO oxidation, methane decomposition, dehydration and dehydrogenation reactions, ethanol conversion, SO₂ reduction and H₂ production.

Other areas of research in 2019 included **adsorption and immobilisation, electronics, cast moulding, sensing, optical materials as well as grinding media**.

The four annual literature reviews between 2016 and 2019 offer an opportunity to identify research trends. Throughout this four-year period, the areas of advanced ceramics and biomedical research have remained popular areas of research,



each with significant potential for industrial applications. While the areas of nanomaterials, nanorods, nanostructures and nanofabrication and advanced coating and functional materials have both grown in popularity based on the number of peer-reviewed publications.

ZIA Executive Director, Dr Keven Harlow, commented:

“Zircon and its derivatives play an increasingly crucial role in today’s modern world in applications ranging from industrial uses to everyday products. This annual literature review offers our members insight into the future potential of zircon to have an even greater impact through emerging technologies.

“Our work now allows us to see annual trends with nanomaterials, biomedical applications, advanced coating and functional materials as well as advanced ceramics being consistently popular areas of zircon related research. We know that zircon is increasingly used in clean energy applications where fuel cells and catalysis have also seen significant increases in research in the last year.”

Notes to editors

1. Further graphic representation of the literature review is available on the ZIA website in the [Publications Review](#). Copies of the ZIA literature reviews are available to members.
2. The Zircon Industry Association (ZIA) is an independent industry association. Its mission is to represent and support the interests of the zircon, zirconia and zirconium value chains, from zircon sand production, to a wide range of downstream products including zircon flour, opacifiers, refractory materials, friction materials, fused zirconia and zirconium chemicals, metal and alloys. Its members currently represent some 80% of the globally-produced zircon tonnage.
3. ZIA operates a strict Code of Conduct and Antitrust Policy.

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